BRITISH SOCIETY
FOR THE
STUDY OF ORTHODONTICS

1963

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Transactions of the

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Wallis, S. E.

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Pringle, K. E.

*London, S.W.*1
Campbell, R. A.
Caseley, Miss R.
Niven, W. N. McL.
Steadman, B. St. J.

*London, S.W.*2
Barnett, J. D. W.

*London, S.W.*3
Hutchinson, G. T.
Morris, V. B.

*London, S.W.*6
Bane, B.

*London, S.W.*7
Levy, Mrs. H.
Markham, H. R.

*London, S.W.*12
Brien, A. B.

*London, S.W.*15
Parr, P. T.
Schrotter, Miss E. C.

*London, S.W.*16
Nesbitt, A.

*London, S.W.*19
Kettle, R. G.
Oliver, B. A.
Oliver, Mrs. Una
Scott, Miss M. K.

*London, S.W.*20
Bilton, B. M.
Johnson, Mrs. E. M.

*London, W.*1
Adams, Miss S.
Allan, F.
Beresford, J. S.
Berman, M.
Bird, E. J. R.
Campbell, A. C.
Clarke, N. F.
Eastwood, A. W.
Endicott, C. L.
Figgis, Mrs. C. M.
Freeman, H. D.
Fry, J. C.
Greenish, V. A. F.
Greig, W. B. W.
Grossmann, W.
Haldcn, J. R.
Halliday, Dr. R. W.
Harborow, G. J.
Hardy, E. A.
Henry, C. Bowdler
Henry, T. Cradock
Hovell, J. H.
Kettle, M. A.
Leatherman, G. H.
McCallin, S. Granger
Patwardhan, Miss S. V.
Pook, R. S.
Richards, H.
Ritchie, Miss J.
Rix, R. E.
Rose, J. S.
Rydemark, J. E.
Schachter, H.
Schofield, J. W.
Schuler, L. H.
Sharland, R. J.
Smith, E. Stuart
Stephens, P. Maxwell
Taralrud, M.
Tupling, L. P.
Walker, F. A.
Westbrook, E. A.
Willcocks, R. W.
Wilson, H. E.
Wongtschowski, K. G.

*London, W.*3
Evans, Miss L. G.
Newton, S. B.

*London, W.*5
Crossman, I. G.
Shotts, Miss N.

*London, W.*6
MacInerney, Miss J.

*London, W.*11
Lynch, Miss E.

*London, W.*13
Shotts, A.
Sutherland, Miss J. H. M.

*London, W.*14
Taylor, A. G.

*London, W.C.*1
Ballard, Prof. C. F.
Fletcher, G. G. T.
Heffer, P. T.
Jefferson, Miss C.
Mills, Dr. J. R. E.
Winter, G. B.

London, W.C. 2
Bass, T. P.
Plint, D. A.
Walther, Prof. D. P.

II. England

Bedfordshire

Biggleswade
Bunker, D. G.

Berkshire

Faringdon
Rayne, J.
Maidenhead
Still, Miss E. M.
Walker, D. Greer
Newbury
Hope, H. D. A.
Pangbourne
Softley, J. W.
Reading
Bailey, J. C.
Wallingford
Bell, J. A.
Wantage
England, Mrs. M. M.

Buckinghamshire

Amersham
Butler, F. H.
Aylesbury
Beaton, A. G.
Isaacson, K. G.
Beaconsfield
Chapman, H.
James, P. M. C.
Chalfont-St. Peter
Blandford, Miss A. M.
Gerrards Cross
Stobie, C. W.

Cambridgeshire

Cambridge
Banke, P. H.
Pickles, R. B.

Cheshire

Birkenhead
Burston, W. R.
Bramhall
Andrew, Miss E. M.
Brock, Mrs. M. C.
Holloway, P. J.
Cheadle
Miller, Mrs. P. S.
Chester
Huggins, D. G.
Johnson, F. K.
Hyde
Hughes, J. P.
Wilmslow
Turner, Mrs. B. M. A.
Wirral
Bush, P. G.
Hopper, J.
McCracken, J. G.
Widdowson, A. R.

Cornwall

Bude
Trays, W. N.
St. Austell
Perks, E. J.
Saltash
Bernard, W. E.

Cumberland

Carlisle
Roberts, G. H.

Derbyshire

Belper
Foster, P. L.
Derby
Eddowes, C. D. W.
McKane, N. B.
Matlock
Crowther, Miss J. M.

Devon

Exeter
Shapland, A. F. D.
Newton Abbot
Coyle, P. R. W.
Paignton
Whitfield, P. F. G.
Plymouth
Burley, M. A.
Endacott, D. J.
Torquay
Turner, J. M.

Co. Durham

Darlington
Jameson, G. D.
Potts, Miss A.
South Shields
Steel, G. H.
Sunderland
Dixon, D. A.
Pettman, J. R.

Essex

Basildon
Benzies, P. M.
Billericay
Hathaway, R. F.

Buckhurst Hill
Ta'Bois, N. C.
Colchester
Seymour, A. J. H.
Epping
Brearley, Mrs. H. E.
Goodmayes
Sherwood, H.
Hornchurch
Luffingham, J. K.
Ilford
Clark, A. G.
Leigh-on-Sea
Clough, E. O.
Klynman, S.
Romford
Ritchie, J. C.
Westcliff-on-Sea.
Salter, R. C. P.
Woodford Green
Martin, H. C.

Gloucestershire

Bristol
Blyth, P. J.
Nicol, W. A.
Peace, Mrs. H. C.
Stephenson, J. C.
Wilkie, J. K.
Cheltenham
Dagger, T.
Valentine, L. H.
Cirencester
Hardingham, A. J.
Frampton-on-Severn
Everard, G. D.
Gloucester
Cookson, A. M.

Hampshire

Bournemouth
Connors, Miss M.
Hooper, J. D.
McCall, Miss M. C.
Wood, N. J.
Havant
Woodward, H. A.
Portsmouth
Dickson, G. C.
Townend, B. R.
Ringwood
Webb, Miss J. M.
Williams, E. B.
Southampton
Davidson, I. F.
Fanner, M. H.
Winchester
Broadway, R. T.

Herefordshire

Hereford
Vaus, K.

Hertfordshire

Bishop's Stortford
Dodd, Miss J. M.
Cheshunt
Munday, M. J.
Kings Langley
Boyd-Cooper, B.
Rickmansworth
Morse, P. H.
Tait, R. V.
St. Albans
Clifton, D. R.
Crawford, J. F.
Watford
Leech, H. L.
Marx, R.

Kent

Ashford
Glass, D. F.
Beckenham
Sandiford, H. E.
Bromley
MacGregor, Miss F. A.
West, V. C.
Canterbury
Bradley, P. E.
Dover
Rumble, J. D.
Gillingham
Ellis, D. S.
Hawkhurst
Black, A.
Keston
Kerr, G. A.
Orpington
Brenchley, M. L.
Sandwich
Irwin, L. M.
Sevenoaks
Christian, G. C.
Rubie, G. J.
Rumble, J. F. S.
Sittingbourne
Thorn, N. K.
Tenterden
Crease, J. A.
Tunbridge Wells
Cross, Miss M.
McAlpine, A. M.
Page, G. Scott
Pilbeam, J. F.
Scoones, J. M.
Spencer, J. S.
Taylor, B. P.
White, Miss B. E. E.

Lancashire

Bolton
Powell, J. E.
Liverpool
Angelman, J.
Atherton, J. D.
Clifford, E. J. S.
Lovius, B. B. J.
Murray, Miss J. P.
Watkin, H. G.
Watkin, Miss P. A.
Wynne, T. H. M.
Lytham St. Annes
Lilley, W. A.
Manchester
Batten, A. G.
Cruikshank, A. J.
Eirew, H. L.
Hargreaves, J. A.
Hartley, D. T.
Jackson, Mrs. S. R.
Kürer, J.
Noar, G. A.
Robertson, N. R. E.
Senior, W. B.
Whittaker, L. B.
Oldham
Hilton, R.
Ormskirk
Pogrel, H.
Preston
Timms, D. G.
Salford
Miller, E.
Sarll, D. W.
Southport
Campbell-Wilson, Miss M.
Robb, G. C.
Warrington
Knowles, C. C.
Wigan
Langford, L. F.

Leicestershire

Hinckley
Freer, T. J.
Leicester
Chamberlain, G. H.
Downing, F. J.
O'Brien, J. D.
Parker, C. D.
Reynolds, B. F.
Smith, K. A.
Smith, T.

Lincolnshire

Brigg
Haynes, S.
Grimsby
Bull, C. C.
Lincoln
Greenwood, A. W.

Middlesex

Edgware
Hudson, J. A.
Strauss, K.
Enfield
Dimock, J. R.
Gould, M. S. E.
Hampton
Bigg, Miss F. J.
Hayes
Swift, P. A.
Hounslow
Mandiwall, H.
Islcworth
Hardy, D. K.
Kenton
Baker, C. D.
Northwood
Hudson, J. A.
Pinner
Eady, B.
Ruislip
Rogers, D. A.
St. Margaret's-on-Thames
Lindon, Mrs. E. G.
Staines
Carr, A. S.

Norfolk

Norwich
Starnes, J. A. G.
Steel, J. K.

Northamptonshire

Northampton
Hughes, H. D. P.
Phillips, J. E.
Wilson, C. P.

Northumberland

Newcastle upon Tyne
Hallett, Prof. G. E. M.
Littlefield, W. H.
Stubley, R.
Weyman, Miss J.
Stockfield upon Tyne
Bennett, D. T.

Nottinghamshire

East Bridgeford
Gould, D. G.
Nottingham
Attenborough, J. L.
Frankland, W.
Tredgold, H. V. G.

Oxfordshire

Banbury
Fraser, A.
Oxford
Harvey, P. D.
Hayton-Williams, D. S.
Savage, M.

Shropshire

Church Stretton
Knight, J.
Oswestry
Broadbent, B. T.
Shrewsbury
Scott, M. F.

Somerset

Bath
Catchside, J.
Franks, Miss F. L.
Langport
Alexander, J. M.
James, W. W.
Taunton
Poulter, N. M.

Staffordshire

Allbrighton (near Wolverhampton)
Williams, T. G. N.
Codsall
Huddart, A. G.
Stoke-on-Trent
Campbell, A. C.
Stone
Friend, Mrs. D. J.

Suffolk

Beccles
Strange, Mrs. M. C.
Ipswich
Broadway, E. S.
Churchyard, R. C.
Lowestoft
Clarkson, J. N. K.

Surrey

Banstead
Foster, Col. E. S.
Camberley
Friend, G. C.
Jadwat, I. A.
Rice, V. G.
Caterham
Cohen, H. I.
Chipstead
Burnapp, D. R.
Croydon
Hill, N. L.
Dorking
Shepperd, R. V.
Epsom
McDonald, Mrs. S.
Esher
Franklin, Mrs. J. A.
Manning, Mrs. J. D.
Guildford
Nelson, J.
Hindhead
Ogston, R. D.
Limpsfield
Titford, K. R.
Redhill
Tittle, J. J.
Reigate
Belcher, R. J.
Richmond
Bell, R. S.
Howard, R. D.
South Croydon
Oliver, P. G.
Surbiton
Frischmann, I.
Sutton
Bransby-Zachary, G. M
Bulow, C. F. H.
Wood, Mrs. R. M.
Thames Ditton
Metcalf, J.
Walton-on-Thames
McIntosh, A. J. C.
Weybridge
Christy, D. F.
Woking
Readings, P.
Reid, D.
Sperryn-Jones, G.
Worcester Park
Bradley, Miss J. A.

Sussex

Battle
Edworthy, S. W.
Bognor Regis
Adam, K. W.
Brighton
Greenwood, A. B.
Chichester
Robertson-Ritchie, D.
Robertson-Ritchie, Mrs. E. L.
Crawley
Dakers, G. H.
Crowborough
Bligh, A. J.
Eastbourne
Abbey, R. A.
Allcorn, A. G. T.
Barlow, E. T.
Horton, J. J.
Etchingham
Ardouin, D. G. F.
Hankham (near Pevensey)
Cullingford, J. T. Powell
Down, G. R.
Graves-Morris, W. R.
Gray, N.
Griffith, H. G.
Martin, D. W.
Whitling, I. E.
East Grinstead
Whitelegg, J. G.
East Hoathly
Lester, H.
Fittleworth
Wylde, Mrs. A. S.
Haywards Heath
Grice, A. R.
Horsham
Pearsall, M. L. H.
Hove
French, J. H.
Harwood, W. U.
Shenton, F. C.
Taylor, S. B.
Littlehampton
Brown, K. H.
St. Leonards-on-Sea
Artes, E. J.
Chisholm, I. M. G.
Young, Miss E. M.
Worthing
Bull, F. Bocquet

Warwickshire

Birmingham
Davis, Mrs. M. E. H.
Day, A. J. W.
Foster, T. D.
Hollick, R. L. B.
Hutton, J. L.
Menezes, D. M.
Norris, N.
Stanley, Mrs. V. K.
Tibbatts, Mrs. M. A.
Coventry
Breakspear, E. K.
Briggs, C. P.
Solihull
Cutler, M.

Wiltshire

Amesbury
Horswill, P. N.
Chippenham
Swann, A. J.
Devizes
Campbell, Miss D. M. Y.
Fawcett, Mrs. A.
Salisbury
Godfrey, O. Harcourt
Hall, J. J.

Worcestershire

Bromsgrove
Munns, D.
Great Malvern
Edmonds, W. H.
Godfrey, W. G.
Malvern
Wallis, R.
Stourbridge
Watkins, B. N.

Yorkshire

Batley
Heylings, R. T.
Bradford
Frazer, Mrs. J.
Wood, T. Jason
Doncaster
Booth, M. H.
Hull
Webb, G. H.
Leeds
Gravely, J. F.
Jackson, D.
Marsh, W.
Miller, J.
Sclare, Miss R.
Middlesbrough
Cook, J. T.
Scarborough
Priestley, P. J. M.
Sheffield
Alexander, Mrs. M.
Alexander, S. H.
Gardiner, J. H.
Holmes, B.
Price, A. H. K.
Strensall
Bowen, Lt.-Col. E. J.

III. Wales

Aberystwyth
Evans, W. D. P.
Barry
Hellier, R. O.
Cardiff
Cousins, A. J. P.
Lewis, A. S.
Colwyn Bay
Duchesne, H. W.
Llandrindod Wells
Capleton, Mrs. L. M.
Llandudno
Jones, J. E.
Swansea
Parry, H. L.

IV. Scotland

Aberdeen
Logie, D.
Bucklyvie
White, Prof. T. C.
Doune
Hood, M. R.
Dumfries
Baker, A.
Dundee
Archibald, W. C.
Martin, J. H.
McCartney, T. P. G.
McEwen, J. D.
Munro, D.
Ritchie, G. S.
Edinburgh
Buchan, A.
Hopkin, G. B.
Houston, W. J. B.
James, G. A.
Kemball, C. H.
Logan, W. Russell
Miller, Miss M. N.

Glasgow
Anderson, H. A.
Campbell, J.
Cockburn, A.
Houston, J. G.
Thomson, Mrs. C. M.
Webster, Miss E. M.

Grangemouth
Stevenson, Wm.
Hawick
Govan, I. G.
Inverness
Jones, F.
Ridley, Miss D. R.

Kirkcaldy
Mears, Miss R.
Methil
Clark, W. J.
Paisley
McKechnie, R.

Portree
MacLeod, D. N.
Stirling
McGonigal, F.
West Linton
Davidson, Miss E. S.

V. Ireland

Bangor
Dallas, H. A.
Belfast
Adams. C. P.

Bonnar, Miss E. M.
Brown, W. A. B.
McKeag, H. T. A.

Dublin
Clinch, Dr. L. M.
Dockrell, R. B.
Finn, S. D.
Fitzgerald, G. M.

Friel, Prof. S.
Keith, J. E.
Kennedy, G. F.
MacCauley, F. J.

VI. Isle of Wight

Ryde
Audsley, C. W.

VII. Overseas Members

Australia

Adamson, K. T.
Bowden, B. D.
Cox, Dr. N. J.
Crisp, B. C.
Heath, J. R.
Norton, R. Y.
Reading, J. F.
Spring, D. F.
Taylor, A. Thornton
Watson, D. C.
Webb, V. P.

Canada

Copeland, Dr. G. P.
Croll, Dr. R. O.
Franklin, G.
Hackie, T. J.
Hargadon, Dr. K. L.
Mulligan, W. O.
Oliver, H. T.

Canary Islands

Gonzalez, R.

Ecuador

Brears, Dr. O. B.

Egypt

Chohayeb, Mrs. A.

France

Demoge, P. H.
Gugny, G.
O'Meyer, R. X.

Hong Kong

Lervy, Major W. K.

India

Ghosh, A. S.
Patel, V. B.

Jamaica

Lyn, Dr. M. R.

Malaya

Chan, B. K.
Cheah, C. K.
Porterfield, Lt.-Col. M. F.

Malta

Demajo, A.
Manara, G.

New Zealand

Ashby, J. W.
Cook, C. C.
Gilbert, G. H.
Lang, E. T.
Suckling, J. G.
Willis, L. E.

Norway

Engh, Olav, Jun.
Krogstad, Olav
Selmer-Olsen, Prof. R.

Peru

Abensur, J.

Singapore

Lee Chee Onn, J.

S. Africa

De Villiers, J. F.
Fainsinger, B.E.
MacLeod, D. N.
Oosthuizen, L.

Northern Rhodesia

Ovington, Major H. M. J. Y.

Southern Rhodesia

Robson, F. F.

Sweden

Ahlgren, J.
Billberg, B.
Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundström, Prof. A.
Mortenson, S. Å.
Pihl, Miss E. M. K.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

Switzerland

Hotz, Prof. R.

U.S.A.

Coval, Dr. N. M.
Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Grossman, R. C.
Jann, Dr. W.
Kelsten, Dr. L. B.
Moss, G. W.
Sillman, J. H.

THE FUTURE OF THE SOCIETY

By A. G. TAYLOR, L.D.S. R.C.S.

It is a high honour to be President of the British Society for the Study of Orthodontics and this is largely because of the special qualities that reside in this Society which I esteem and which I hope I shall make evident in the course of this address.

Presidential addresses generally fall into three classes. The first, which you generally hear, is a piece of original work of outstanding quality. Another, which is rarer and can be quite exciting, is a man on his hobby-horse; and the last is general in character. Because I am not properly a practising orthodontist, but your President by seniority and love of the Society, I have no choice other than to talk to you generally about our meetings, about the development of the Society, and the indications these give to future achievements. At times I intend to digress wilfully from my theme in an attempt to season the dish.

My most concrete claim to seniority is that I have been a member of the Council continuously since 1939, most of this period as librarian, but there was a fascinating period of a few months when I acted as secretary and saw what happened on the actual dais. During this long period of twenty-four years the membership of the Council has changed many times, and it has been a wonderful experience to follow the subtle changes in the patterns of thought in both the conduct of the Society and the field of orthodontics. It is the development of this Society that is my theme because of my special knowledge of a subject that may be obscure to the ordinary member and can only be studied in the minute books. It is from the past and recent history that I hope to point a finger towards the future.

To begin at the beginning. There is something in the very title 'The British Society for the Study of Orthodontics'. And this is not the occasion to remark on the Greek scholarship of our founding fathers who rightly preferred 'orthodontics' to the bastard noun 'orthodontia', which had been the currency of their day. Rather, I wish to draw attention to the style of the title 'for the Study of Orthodontics' rather than 'Society of Orthodontists', because this has been the key to the development of our Society.

The bye-laws state that the object of the Society is the promotion of the study of orthodontics, and any person interested in this study shall be eligible for ordinary or, if residing abroad, corresponding membership. It is plain from the context that persons other than dental or medical practitioners can be accepted for membership, and the Society thus rests on a broad and liberal base and can never be a coterie.

In the early days there were no whole-time orthodontists and the Society wore an amateur air. With the passage of time there has been a substantial increase in the practice of orthodontics with, at first, a university readership in the subject, and now there are professors and scores of whole-time orthodontists: yet the dilettante, the amateur of orthodontics, the part-time practitioner of the art, still holds his place in the Society. I think the reason for this is in the way we hold our meetings. Many of the papers are on the practical level; others are of such fundamental value that they go beyond the promotion of the study of orthodontics and touch the practice of dentistry in nearly all its aspects, thereby broadening the outlook of the general practitioner to his great profit and to the benefit of dentistry in general. And it is not only the formal meeting, for you are well aware that members are expected to attend the informal talk, with its orthodontic flavour, that follows all our formal meetings.

Sometimes it is said that the general practitioner is in the best position to estimate the value of orthodontic theory and practice.

Presidential Address presented at the meeting held on 14 Jan., 1963.

It is he with the family practice who sees the child before treatment, who refers his difficult cases to his specialist brother, and who sees the really long-term results expressed not only in terms of dental health, harmony, and efficiency, but in terms of human happiness too. This knowledge is often concealed from the specialist, and it is a pity our general practitioner members are shy in sharing their experience with their colleagues. But it has to be a strong-minded person who is prepared to speak before those who have all the resources of the modern orthodontic departments, in knowledge and experience, at their backs.

The specialist orthodontists are fully alive to the shortcomings that go with specialization and, more and more, are going into the field themselves, but much of the wanted information is in the hands of the general practitioner members of this Society and they should bring it forward. The long-term result of treatment is still not an open book.

As this Society has for its object the promotion of the study of orthodontics, it does not indulge in political activities. There have been exceptions, of course, such as during the plan-happy Beveridge era when a successful end to the last war was in sight. Then two reports were published, the first on orthodontic treatment for elementary schoolchildren and postgraduate orthodontic training, and the other on undergraduate education in orthodontics. Those who have read these reports will remember that they were both accompanied by powerful minority reports, and it can be said that this venture outside our usual field was not a glorious success.

This abhorrence of politics has some odd results. Who is to speak for orthodontists when their place in the profession is considered, their terms of service in the salaried section, the professional relationship and structure in school clinics, general and teaching hospitals ? Not this Society, but the British Dental Association and others who are usually not orthodontists and whose interests are in other aspects of dentistry which are not always compatible with the practice of orthodontics.

The Society's report on postgraduate orthodontic training did recommend a diploma after examination. This was in 1944, and the first diplomas in orthodontics were granted by the Royal College of Surgeons ten years later, in 1954. I do not think this result can have been due to active lobbying by this Society, but I feel certain it was due to the work of this Society working indirectly by raising the prestige of orthodontics as a scientific discipline in the eyes of the dental and medical professions. By keeping diligently to our founders' objectives we shall enhance not only the study but the practice of orthodontics. This is a merit that sticks to those members who actively practise orthodontics. It's rather like that tag, 'Honesty is the best policy'; it pays dividends as well as being an ethical precept. In my experience, concentration on the academic and clinical sides can produce results in the political field, especially in standing and status and the material assets that go with status, that are just as impressive as the results that are obtained by more direct routes.

I like to regard this Society as a learned society. It is difficult to define a learned society, but there are criteria that are taken into account when income-tax exemption is granted to an institution classed as a charity. Our Society probably enjoys this classification because it was established for the promotion of education and so enjoys exemption from income tax and will, when it becomes a householder, probably enjoy rate relief as well. The members, too, enjoy relief on the sum of their subscriptions, and this now applies to the whole-time salaried officer as well as the part-timer and those in private practice: to obtain this concession a test was applied and the Treasurer had to submit copies of our *Transactions* to the Inland Revenue authorities. The Society passed the test, and I am confirmed in my belief that we are a learned society. Learned societies often receive other forms of official help and encouragement. In some instances the Government itself provides accommodation and funds, and in others the universities give similar assistance and urge their members to join the appropriate society.

In preparing this address I looked around for other bodies of more ancient birth, but similar in origin and aims, so that I could use their histories of progress and growth as a yardstick both to look at our own progress up to now and to guess as to our future. The most obvious parallel is the Royal Society, which, some two years ago, celebrated its first three hundred years with the publication of a short history. The Royal Society, like the B.S.S.O., was founded by a group of men who had a lively interest in the promotion of science when that discipline was in its infancy. Among its early members it included one who dabbled in alchemy and had pretensions to transmuting base metal into gold. After his claims had been challenged he was at last prevailed on to demonstrate his transmutation technique before a small committee of the Royal Society. It was a tragic occasion as the alchemist took a lethal potion and died with his apparatus set up and in the presence of the members of the committee. I can find no parallel in the history of the Society to that remarkable event.

The early members of the Royal Society included dilettantes and men of affairs as well as those whose whole lives were bound up in science, and this was so for the first two hundred years, for not until 1847 were the statutes revised and membership limited to persons devoted to the pursuit of science.

In its early days the Royal Society was often in financial difficulties. This may seem strange as it enjoyed the support of many of the rich and powerful. But the reason was simple: the subscription of one shilling each meeting, to pay for the experiments that were a feature of the early meetings, was a considerable sum in the seventeenth century and too many members failed to pay their subscriptions. Sir Joseph Banks, famous in his own right as well as for his association with that great man Captain James Cook, was a man of ample fortune, and on his election to the Presidency he devoted his considerable talents, and much of his money, to establishing the Royal Society on a sound basis. In the process he continued as President for over forty years and became the most autocratic of presidents. In spite of these early money troubles the Royal Society had several benefactors and I need only mention Copley, whose memory is enshrined in the annual award of the Copley medals.

The B.S.S.O. has always enjoyed financial stability because of a long line of prudent treasurers, and blessed indeed is the society that has no financial crises. As yet we have had no remarkable benefactions, although the museum and library contain objects of a different value, often worth more than money, that have been given by generous members. It is because of our excellent financial position that the Society has been able to honour its founder with the Northcroft Memorial Lecture, which carries with it an honorarium and a distinction adequate to secure the lecturer we desire, often in disciplines on the fringe of orthodontics. Last year we heard Mr. D. A. Dixon read his thesis that won him the distinction of being the first Chapman prizeman, and this prize, which is offered annually for an original paper of outstanding merit by a younger member of the Society, was established to honour Harold Chapman our oldest, most famous, and much beloved member.

I have mentioned the museum and library. I have read somewhere, but cannot trace the reference, that a museum and library are essential elements in the make-up of a learned society. Now there are some who think our museum and library are not sufficiently used by our members, and it has been suggested that the museum, at least, would be more accessible if it were to be presented to the Royal College of Surgeons and included in that collection. It is the tenor of this address that our Society, having survived infancy when mortality is high, is well launched on a career of scores, if not hundreds, of years and if it continues to prosper, of which I have no doubt, the time will come when it will be a householder and not a casual tenant. When this time comes the museum and library will really come into their own.

To pass from the museum and library to the annual *Transactions* of the Society is a logical

step, as each of these is the special responsibility of an officer of the Society. If you study one of our earlier volumes you will be astonished at the great improvement our recent editors have effected. This really started with the 1947 volume, when Mr. J. F. Pilbeam was editor, and since his time the standard of book production has been well maintained and, I think, improved. This has not been accomplished without a series of crises as we moved from one publisher to another, but since Messrs. John Wright & Sons Ltd., of Bristol, took over we have been in smooth water. The firm publishes a B.S.S.O. supplement to the DENTAL PRACTITIONER and these supplements are the basis for the annual volume of *Transactions*. I shall not enter into a discussion of the financial arrangements that made this possible, but I must remind you that the Treasurer used to refer to a shortfall paid to Messrs. John Wright, and this was a subvention that varied in inverse proportion to the number of members subscribing to the DENTAL PRACTITIONER. These member subscribers now exceed the agreed number and the shortfall is no longer paid.

Any individual who reads a paper to one of our meetings regards it as an honour and most are anxious to see their papers in print as soon as possible. A tardy person who waits months before sending his script to the Editor delays the publication of the annual *Transactions*, and it follows that part of the value of the supplement in the DENTAL PRACTITIONER is the early publications of papers, as they appear there months before the publication of the *Transactions*. As the Society jealously upholds its copyright in papers read at its meetings, the lecturers have no other outlet.

A feature of publication of papers, both in the *Transactions* and the DENTAL PRACTITIONER, is the addition of an account of the ensuing discussion. The shorthand writer who sits at the desk below the dais is a complete expert in this field, and, as in Hansard, those who take part in the discussions receive proofs for revision, and behind them again is the Editor so that the discussions read in print with the same spirit as animated the spoken word and often more fluently. There have been occasions when the discussion was of equal value to the paper, or even more interesting, and I understand that these printed discussions are highly regarded by overseas readers.

The mention of overseas readers is a reminder that the *Transactions* have now a world-wide circulation. This is a relatively new happening and has grown without any promotion pressure from this end. The high esteem in which this Society is held in the orthodontic world is to the credit of the excellence of our meetings and to the Editors who have served us so well.

Fundamentally the annual volume of *Transactions* has not changed since the publication of the first paper-back part in 1907. It is no more nor less than transactions, as papers and demonstrations have to be delivered before a meeting in order to be published. There are no reviews, letters, or editorial statements such as ornament other periodicals, and to include any of these features would mean a change of title and a fundamental departure in the policy of the Society. I think it is reasonable to claim that our *Transactions* are as good as any textbook on orthodontics, and one thing I hope of the future is the continued improvement in the standard of papers published.

The change of fashion in the matter of papers is an interesting subject. At one time they will be anecdotal and during another period severely practical. Indeed, at a recent Council meeting one of the members, recalling an era of theoretical addresses, said that the mere mention of a practical subject would have been greeted with a general intake of breath. It is often the short communication or demonstration that contains the germ of an original idea, and I have high hopes that short communications, that used to be a feature of our meetings, will once again take their rightful place.

Now as to the manner of presenting a paper. I must have attended a hundred or more meetings and I think the general standard of reading papers is rather good and papers are read in an interesting and entertaining way, but I should like to draw attention to a few

shortcomings that sometimes crop up. In the first place you will have noticed that the back of the hall is always well filled. The front rows are only occupied when the meeting is filled to overflowing. This is not peculiar to this Society and is not, I suspect, a politeness to ensure that the hard of hearing have their vantage point. Therefore the speaker must either ask his audience to come forward or speak up well to hold the attention of those at the back and in the warm and those near the projector, where speech is muffled by the noise of the blower. Microphones are usually dismal and I associate them with the worst of 'pop' art, but I received a revelation when I heard the dancer Beriosova speak her lines in the ballet *Persephone* at Covent Garden. She had a microphone and transmitter concealed on her person and her voice as heard by the audience was firm, clear, and loud enough.

In the second place the speaker must be skilful with his illustrations. It is a bad thing to show too many slides as there are those in the warm darkness who will take the opportunity of having a nap. And these illustrations should be illustrations and not tables of figures that cannot be digested because there are too many numbers and too small digits, nor should they be photographs of models that do not clearly demonstrate the point that is being made. There is an excellent section on this subject in a recent paper by Trott (1961).

The essence of the scientific method is accurate description, and measurement is an aspect of accurate description. I have heard members at the back of the meeting grumble at figures that were brought forward by a speaker who had done painstaking and fundamental work of orthodontic significance, and I should like to deplore their attitude. At the same time there should be some sympathy for their point of view. The paper that is devoted to a statistical survey of the positions and relations of the teeth at certain ages does not lend itself to dramatic or even exciting presentation. Set down on the printed page it is an enduring and valuable work, a foundation for the future. This, too, is the sort of work that may be more frequent in years to come, and I am at a loss to suggest how such papers are to be presented. There is only one way out that I can suggest and even this is dubious; it is to give a racy address on the technical difficulties encountered in the field together with a summary of conclusions and to submit the serious paper and tables for publication in print.

The scientific method of accurate description and measurement is one that engages us closely. It is the key to classification and classification again is the key to diagnosis, treatment, and prognosis. The problems of growth with a constant evolution in the morphology of the mouth, jaws, and face do not make the application of scientific methods simple. Classification of orthodontic states is still ruled by Angle's classification even when we are aware of the shortcomings of this system. We all look forward to the day when Angle is superseded by a more accurate and yet as simple a classification. It is the simplicity of Angle's system that holds us in his spell. So we use bastard systems; that is, Angle plus something, whether it be skeletal pattern, or orofacial musculature, or what have you. It is to the credit of this Society that much of the original work on these problems endures in the pages of its *Transactions*, and I hope it will continue.

A useful tool that has come to our hands in recent years is the standardized lateral skull radiograph on which lines can be drawn and angles measured and compared. Too often I think there has not been sufficient discretion in the use of this method. Hallett (1959) and Broadway (1962) have pointed out the failings of this method of examining changes in tooth and jaw relationships, but there has been no development in this technique so that its value does not exceed those old tried recording methods of plaster models and photographs.

While on the subject of measurement I should like to stray from my path to consider the new standards that have been, or are about to be, introduced. The metre was originally intended to be the ten-millionth part of the earth's meridional quadrant, but

in 1889 it was, like the yard, defined as a standard metal bar, and in 1960 it was redefined as a length equal to 1,650,763·73 wavelengths, *in vacuo*, of the radiation corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the atom Krypton-86. It is likely that our own yard will be redefined as 0·9144 metre exactly.

Eighteen months ago an eminent anatomist, a former member of this Society and a true friend, uttered a home truth when he remarked that orthodontists believe in clichés. Of course it was thrown out in epigrammatic form, but I have been trying to get at the truth of the remark. My dictionary defines a cliché as: 'a. A stereotype block; a cast or "dab"; *esp.* a metal stereotype of a wood-engraving used to print from. b. *fig.* A stereotyped expression, a commonplace phrase 1892.' Another definition that came to hand recently calls it 'a synthetic and odourless preparation, the lubricant of the social machine'. In short, a cliché gains general approval at the cost of accuracy so that it is often difficult to understand what many orthodontists are trying to express. But how are we to rid ourselves of the cliché? The answer is, by taking thought. This Society has, in recent years, avoided the subject of nomenclature and the naming of parts with accurate and agreed definition is the essence of this. The time may not yet be ripe and I doubt if our ideas and concepts are crystalline enough for such an exercise. This is another thing for the future, but we must rid ourselves of the cliché if we are to think clearly, communicate usefully, and progress. It is the scientific method.

Talking about the scientific method leads on to scientific investigation which is an increasing activity in orthodontic circles, both for its own sake and for the kudos it can earn the investigator. The following is said to be the common sequence in an investigation of a biological problem: (1) The relevant literature is critically reviewed; (2) A thorough collection of field data is conducted; (3) The information collected is marshalled and correlated and the problem is defined and broken down into specific questions; (4) Intelligent guesses are made to answer the questions, as many hypotheses as possible being considered; (5) Experiments are devised to test first the likeliest hypothesis bearing on the most crucial question. In this analysis I am following W. I. B. Beveridge (1961), who looked at the lives, methods, and achievements of many eminent scientists with the eye of a scientist and tried to catch the essence of their genius. Among their attributes he instances imagination, intuition, reason, and chance. But there is a better word than 'chance', it is 'serendipity'—the faculty of making happy chance finds. The French envy us this word. Galvani, von Röntgen, and Sir Alexander Fleming were men who enjoyed serendipity.

But this is a digression and, returning to my theme, I want to draw your attention to the Council of the Society. It is a self-perpetuating body that has absolute control of your affairs; an oligarchy. Bye-law 18 states: 'Nominations to the Council shall be made by the Council and Nominations may also be made by post by four properly qualified Members if received by the Secretary at least seven days prior to the Ordinary Meeting before the Annual General Meeting.'

In practice, the nominations are always made by the Council and there have not been four properly qualified members so independent as to put up a candidate. Therefore the Council is self-perpetuating. Bye-law 32 states: 'The Council shall have the management of the affairs of the Society.' Nowhere are there indications that anyone, other than the President and Council, can get a special meeting convened nor is there any mention of resolutions from the body of members. Therefore I claim that the Council has absolute control of the Society's affairs.

The oligarchic rule may be the best for this kind of Society and I like to think the Council has always enjoyed its members' confidence. The bye-laws ensure there is a steady infusion of fresh blood into the Council. The Council members have their ears close to the ground and are quick to respond to any breath of opinion as I have indicated at places in this address. This self-perpetuating body always

tries to be representative and is particularly sensitive to opinion from the provinces. About half our membership is based on London, and soon after the war the question of branches was considered, but it was not really practical as the provincial members are spread fairly uniformly over the country, with no large congregation at any centre that could act as a branch focus. The way out has been the country meeting.

The first country meeting was held at Sheffield in 1955, and, with one exception, this has been an annual event. It is my opinion that these meetings are a development of first-rate importance and have proved highly successful. There are two aspects of the country meeting that should be mentioned. The first is the date. If, as is often the case, the meeting is held in or around a dental school the only available time is that of the Easter vacation, which is also the time of school holidays when orthodontic practitioners are fully engaged in their practices. So far, we have managed with an uneasy compromise and the Council can see no way of resolving this problem.

The second aspect that presents difficulty is the shape of the country meeting programme. So far this has been quite fluid. Generally, on a Thursday the enthusiastic golfers enjoy the country air—and it is agreed that they are the only ones who do. On Friday and Saturday there are formal meetings that occupy about as much time as the total of our London Monday evening meetings, and on Saturday afternoon is a table demonstration meeting, which fades away as the members leave for home. There is, too, a dinner which is nicely balanced between the formal and informal and is our greatest social occasion of the year.

The country meeting has practically doubled the material presented to the Society and published in the *Transactions*. There have been times when doubts were expressed that we might be scraping the barrel for papers, and that some might not be of a sufficiently high standard, and other doubts that if we failed to hold a country meeting we should fall short in providing enough material for our supplemcnt in the DENTAL PRACTITIONER. It is now clear that we are avoiding both these difficulties, and the experience we are gaining from holding these country meetings will help us to improve their shape.

By 'shape' I mean that we must try to escape from an unrelated collection of papers and attempt to have at least a core of papers on related subjects and to alter the arrangements of the meeting in so far as the demonstrations are concerned. In the years before the country meeting there was a special meeting in May devoted to table demonstrations, and it used to be the best attended meeting of the year, whereas the table demonstrations at the country meeting are not so well attended because they come at the tail-end of an intensive meeting.

This year the demonstrations will be moved to Friday afternoon to the advantage of the demonstrators, and making a refreshing break in a solid phalanx of papers for the ordinary members. To attain a fitting finale, and to maintain the interest of members on Saturday afternoon, Dr. W. J. Tulley has been invited to tell us about his visit to Honolulu and the other cities of the United States and to show his film.

Also, this year an experimental research session of short working reports will be held on Thursday afternoon at the West Norwich Hospital. This is a specialist meeting, intended for the benefit of those members who are engaged on, and are interested in, research projects, and is in the nature of a conversazione, when working reports will be briefly presented and discussed. It is hoped that this will be to the benefit of the reporters as well as to the benefit of those with research projects in mind. Orthodontic research is often long-term and offers opportunities for such informal exchanges. This meeting is a novel departure for the Society, and as it has a specialized appeal that might be lost if turned into a general meeting it has been decided, also as part of the experiment, to limit attendance to those who make special application.

I did think of talking about financial matters, but I know that all the members are

satisfied with the value they get for their subscriptions and with the financial stability of the Society, so that to talk of money is unnecessary. For this we must thank our Treasurer, and I must thank our Secretary who has so much more work to do than in the past, and on whose shoulders I shall lean heavily this year.

Finally, I wish to claim your even more active interest in the work of the Society. I have tried to show how it has grown, how it functions, and the way I think it will develop; but this all depends on the ordinary member. The Council is always eager to learn your views and to receive offers of papers and short communications.

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DISCUSSION

Dr. W. J. Tulley endorsed the President's remarks concerning papers which were read with a profusion of data. While these were necessary and should be published, they did not make for verbal presentation.

Mr. E. J. R. Bird said he was glad to hear the President's remarks about general practitioners. With a busy practice they did not have time to do much study or much research, and unless the paper was on some practical aspect in which they were engaged day by day, it was very difficult for them to get up and pass any comment or ask any questions on the paper.

He would also like to agree with the President's remarks about the data on the screen. He had often had a very pleasant nap while such things had been presented!

He thought, too, that there was a lack of correlation between the results that the practitioner saw over the years and the practice and research, as it were, presented by the specialist members. Perhaps, somehow or other, these two things in the future might be brought together.

Mr. K. E. Pringle said that it seemed to him a pity that the members did not occasionally offer a name of a candidate for Council membership. He was sure it would be well received by the Council.

Mr. F. Allan said that it had been completely glossed over that the Chapman Prize was not awarded this year. He wrote a paper for the second time on the importance of lower arch treatment, to show that lower arch treatment can shorten treatment time, give rise to a better result, and need not take more chairside time on the aggregate.

After two entries for the Chapman Prize, he was too discouraged to enter for a third time, and had to listen to papers which did not help orthodontic practice at all.

Mr. S. G. McCallin wondered if the President, in his researches back through the *Transactions*, had noticed any change in the type of discussion which followed papers. It seemed to him that they used to be of a more earthy nature. People were not afraid to look foolish, and there had been lively discussions.

Mr. L. H. Russell wondered if it would be possible to work out research projects on similar lines to those carried out by the General Medical Practitioners' Society, where a few cases from each person of the Society could be correlated together to present quite a staggering piece of research. This would give general practitioners a little more scope and add to the interest of their everyday work.

Mr. R. E. Rix asked whether the President had any ideas as to the optimum size for our Society. He had a feeling that numbers could get too great when discussions after meetings became too careful.

Mr. V. G. Rice said he always understood that originally the Society was formed to promote the study of orthodontics and surely the majority of orthodontics should be done by the general practitioner. Many recent papers went beyond what the general practitioner could undertake or really appreciate.

Mr. J. S. Beresford said that papers in recent years, he felt, had very clearly told us what we could do and what we could not do. There was a wealth of definition and knowledge in some of the recent papers to the Society, which should permit the general practitioner to know the limitations of practical orthodontics. These limitations applied to the man who practised only orthodontics just as much as to a general practitioner.

Mr. A. C. Campbell remarked that the last speaker had said that over a period of time we learnt what we could do and what we could not do. He suggested, however, that we might increase the number of occasions upon which we discussed what we ought to do and what we ought not to do. We have had a number of papers in the past from periodontologists, for example. He thought that if we could bring in more other people, not just the general practitioners, it would perhaps be helpful to us all in the future.

Mr. E. K. Breakspear said he believed the paper was most penetrating and valuable. He would like to see a session on 'making the best of a bad job'. We spent most of our days dealing with the imperfect cases, which must produce imperfect results, but our job was to make something as nearly perfect as possible. Could we see some more of the imperfect results by which we had to earn our bread and butter?

The President thought it would be improper, for him, to reply. The whole point of the discussion was so that the remarks which had been made should enter the ears of the members of the Council who were present, so that they might influence them in the future policy of the Society.

A SUPPLEMENTAL MOLAR

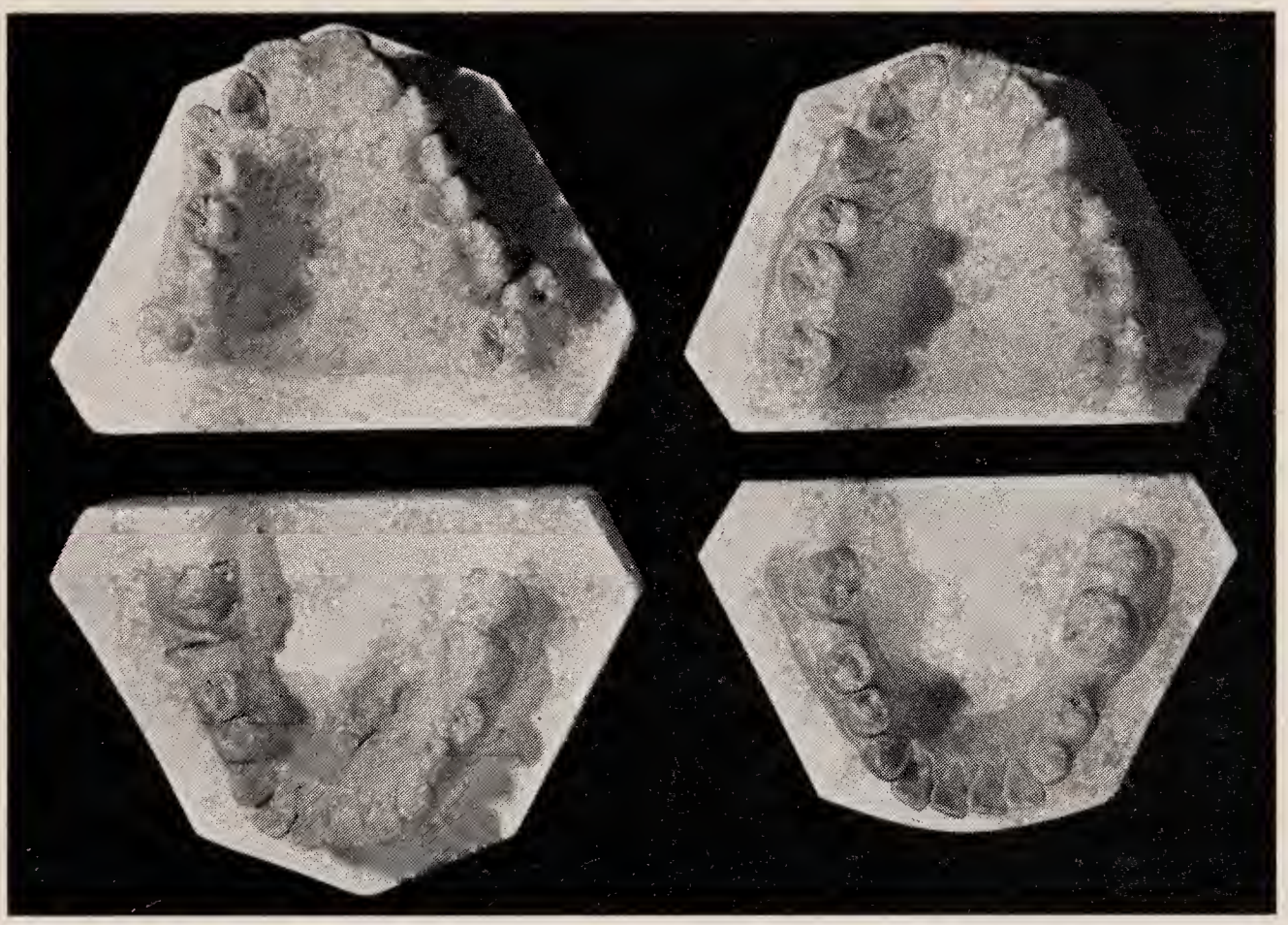
By ESTHER M. N. CARVALHO, L.D.S. R.C.S. (ENG.)

Orthodontist, Middlesex County Council

A GIRL aged 12½ years was referred to me for treatment of the outstanding upper right canine and also because of the presence of two supernumerary teeth in the molar region. She was of Indian appearance and had come to England in 1958 from the Dutch West Indies, having also lived in British Guiana. She had four sisters and two brothers. It proved somewhat difficult to interview the mother, but there was apparently no history of supernumerary teeth in the family.

On examination, she had a bimaxillary proclination on a mild Class II dental base with slight anterior open bite and excessive overjet. The upper right canine was crowded out of the arch and there was upper incisor crowding. There were, and still are, a marked tongue thrust, competent lips, and a persistent lip-to-tip-of-tongue resting position. She has a tooth-apart swallow. She used to suck her thumb; and apparently still does so at times. She has an interdental sigmatism.

All the permanent teeth were present and erupted, except the lower right first molar, which had been extracted, and the upper right second molar and all of the third molars, which were unerupted. The lower left second premolar was unsavable. In addition, two supernumerary teeth were present. It appears that the extra length of the upper buccal segments has caused crowding in the canine region and labial segment. The condition is illustrated in *Figs.* 1–4.



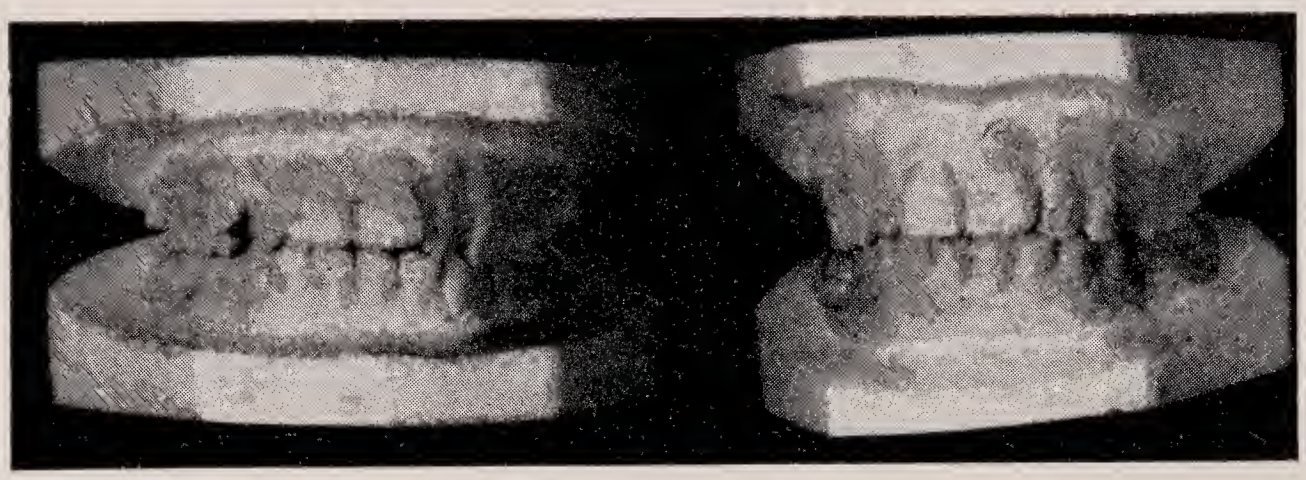
A B

Fig. 1.—Occlusal view of models showing the condition; A, before treatment, B, during treatment.

The two supernumerary teeth and both upper first premolars were extracted. The upper canines, and later the incisors, were retracted with removable appliances. The prognosis was fair as the unfavourable tongue behaviour was balanced by good lip musculature.

Presented at the meeting held on 11 Feb., 1963.

The upper incisors are shovel-shaped, the laterals more markedly so than the centrals. Shovel-shaped incisors have been described by several authors, notably Hrdlicka (1920), Dahlberg (1945), Moorrees (1957), and Miles and Carbonell (1961). Dahlberg states that they are most common in American Indians, Chinese, Japanese, and Eskimoes and uncommon in Europeans and Negroes. Moorrees confirms that they are generally characteristic of Mongoloid stock. Miles and Carbonell have found a high prevalence of these teeth in English skulls from A.D. 400 to 1800, the condition being more common on maxillary lateral incisors. Moorrees classifies the condition as 'marked shovel, shovel, semi-shovel and trace shovel'. It would appear that the condition in the English skulls of Miles and Carbonell probably lies between the classes of semi- and trace shovel and, in the case here described, the laterals are classed as semi-shovel and the centrals as trace shovel.



A B

Fig. 2.—Anterior view of models showing condition, A, before treatment; B, during treatment.

A

B

Fig. 3.—A, Occlusal view of the extracted supernumerary teeth. B, Mesial and buccal views of the left supernumerary.

The supernumerary teeth lie distal and buccal to the first molars. They are well-formed teeth, with crowns similar to each other and to those of the second premolars. The roots were incompletely formed at the time of extraction, but resemble premolar roots. The wrinkles or fissures and cusps bear a strong resemblance to each other and to the second premolars and to the anterior part of the first molars. One receives the impression that these teeth are part of a series and are under the same influence as other teeth.

Gardiner (1961), in a comprehensive review of the subject, lists six theories to explain the origin of supernumerary teeth:—

1. Atavism. This has now been largely discounted.

2. Excessive growth of the dental lamina as suggested by Black (1909).

3. Proliferation of remnants of the tooth band or dental lamina—this was also put forward by Black and has been found to

account for certain rudimentary teeth without enamel in the incisor region.

4. Dichotomy of the tooth germ.
5. Heredity.
6. General conditions, which would include disease such as cleidocranial dysostosis.

tooth is also dependent on timing as the field is active for a limited time. Thus, if a supernumerary tooth appeared while the field was in full force, one could expect that supernumerary tooth to be fully formed and typical of those in the region in which it occurred.

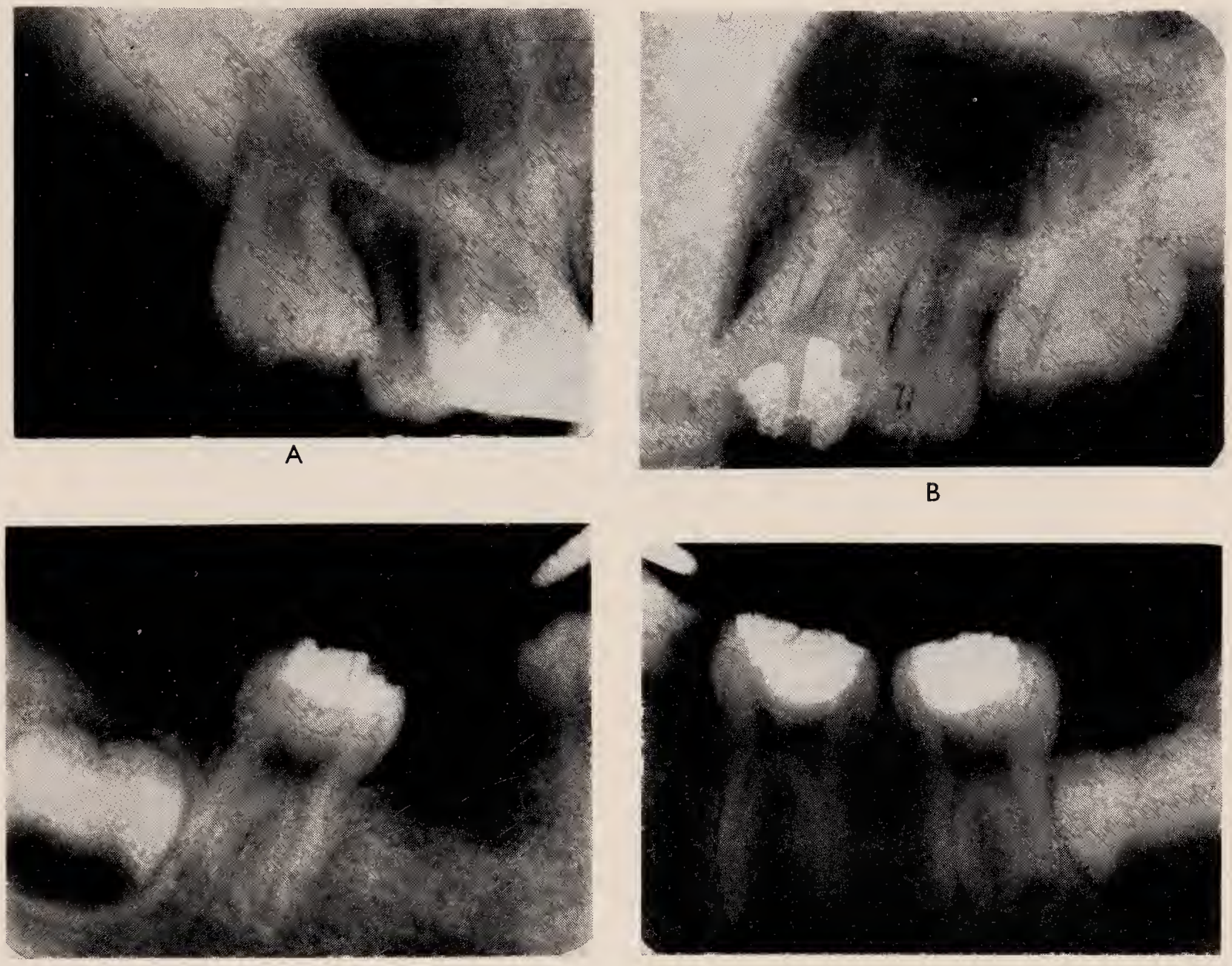


Fig. 4.—Intra-oral radiographs of the molar regions showing the degree of calcification of the roots of the supernumeraries and of adjacent teeth. A, Upper right segment; B, Upper left segment; C, Lower right segment; D, Lower left segment.

Of these six factors, the two which may concern us are excessive growth of the dental lamina and dichotomy of the tooth germ. One would expect heredity to play a part, but, if it does, I have not been able to discover it. Butler (1939) has advanced the 'field concept' and this has been applied to the human dentition by Dahlberg (1945). According to this theory each type of tooth—incisor, canine, or molar—is subject to a separate field of influence and this field has a pole. The influence of the field is strongest closest to the pole. The influence of the field on a developing tooth is also dependent on timing as the field is active for a limited time. Thus, if a supernumerary tooth appeared while the field was in full force, one could expect that supernumerary tooth to be fully formed and typical of those in the region in which it occurred. If activity of the field was diminished, stopped, or changed, then the supernumerary tooth would be a modification and dissimilar to other teeth in the region. Field activity also governs other tooth characteristics such as shovel-shape of the incisors.

In the present case, if the tooth is a third premolar, it would be under the same field of influence as the other premolars and erupt in series with them—as is the case. In the upper right segment (*Fig.* 4 A) the supernumerary tooth has erupted before the second molar and, on the left (*Fig.* 4 B), the supernumerary tooth

is more fully erupted than the second molar. The teeth are, however, in the wrong place for supernumerary premolars which erupt lingually or buccally to the normal premolars. The teeth cannot be fourth molars because, again, they are in the wrong place and

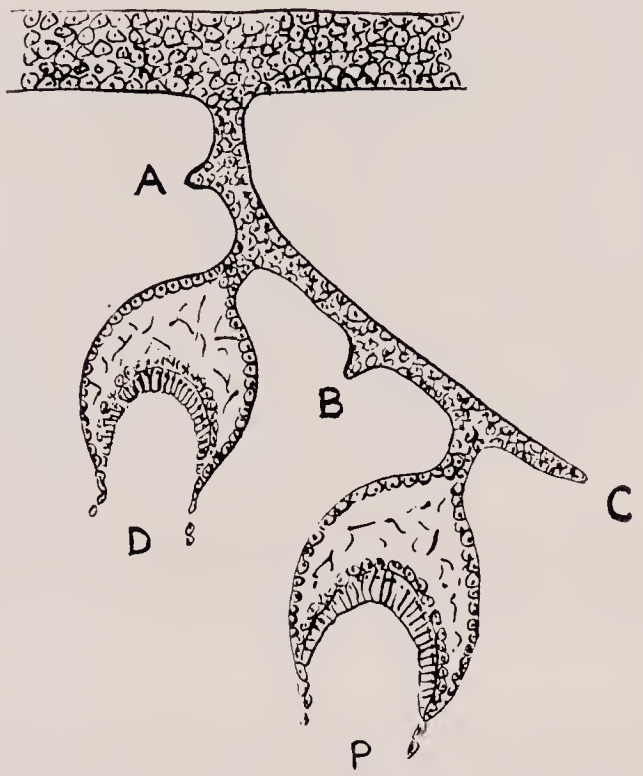


Fig. 5.—A developing tooth-band showing the situation of deciduous tooth germ (D); permanent tooth germ (P); site of predeciduous type of supernumerary tooth (A); site of more common type of supernumerary (B); and site of post-permanent type of supernumerary (C). (*Reproduced from Gardiner* (1961), '*Dental Practitioner*', **12**, 63.)

erupting at the wrong time. They do not appear to be paramolar teeth as described by Bolk (1914), since such teeth are rudimentary and occur lateral to the molar row, usually between the second and third maxillary permanent molars.

Fig. 5, taken from a paper by Gardiner (1961), indicates the way in which supernumerary teeth may develop from the tooth band. Those developing at A erupt with the deciduous dentition, those at B with the permanent dentition, while those developing from the point C would erupt as a post-permanent type of supernumerary. This last type has been seen as partially developed premolars occurring after the regular premolars have completed their root formation. Again, these supernumerary teeth do not fit in with this, since they must have developed earlier than the theory suggests and appear as fully formed premolars.

Alternatively, they may be incompletely formed molars. Professor P. M. Butler (personal communication) has suggested that one tooth germ in the second permanent molar region divided unequally into two parts. There is insufficient material to form a complete second molar, and in such cases it is usual for only the anterior half of the tooth to develop. Reference to *Fig.* 3 would show that the teeth are more like the anterior part of a first molar than a typical premolar.

It is therefore difficult to decide the exact nature of these supernumerary teeth. It would appear most probable that they arise as a result of division of the tooth germ of the second permanent molar, there being insufficient material to produce a whole molar tooth. Alternatively, they may represent the anterior part of a molar successional to the first permanent molar, since it is generally believed that the human permanent molars in fact belong to the same series as the deciduous molars.

Acknowledgements.—I should like to express my thanks to Professor C. F. Ballard, Professor P. M. Butler, Dr. D. Brothwell, the Secretary and the Editor of the Society, and my colleagues, and to the staff of the British Dental Association Library for their assistance.

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DISCUSSION

Mr. J. C. Ritchie said that the teeth referred to reminded him very much of four such teeth he removed from the tuberosity of a lady in 1939. Three were the same in shape, form, and size as that described by Mrs. Carvalho, and approximately two-thirds the size of a second molar tooth. They were followed by an additional supernumerary tooth which was simple in character.

THE HEREDITARY TENDENCY IN TWO CASES OF PARTIAL ANODONTIA

By JOHN C. RITCHIE, L.D.S. R.C.S. (ENG.)

Orthodontist, Westminster Group of Hospitals

In considering the question of partial or complete anodontia, it must be assumed that this is a somewhat uncommon condition. It would probably be true to say that most orthodontists see one or two cases during the whole of their practising life, and indeed this abnormality has only been reported on, to this Society, on one occasion during the last decade; Mr. H. L. Leech presented such a case at the Shefficld Meeting in 1955.

The cases which are presented today are those of two brothers (*Fig.* 1). Their present ages are 15 years and 3 years, and it was when the mother told me about her second son having very few temporary teeth that it seemed that the hereditary tendency and the family background were worthy of invcstigation.

There are great similarities in the dental arches of these two boys while their temporary teeth are still present, and when models of their teeth are looked at they are almost identical (*Fig.* 2). The models on the right are those of the younger brother, aged 3 years. The teeth present are $\frac{\text{E C A / A C E}}{\text{E C \ / \ C E}}$, which represents half their normal complement.

Fig. 1.—Right profile of the two brothers aged 15 years and 3 years.

The arches are of similar size (*Fig.* 3). The only difference is in the bite, the elder brother being Class I and the younger bcing pseudo-Class III and crossed on the right side, purely because of the cuspal interference in the region of the temporary canine teeth. The size and shape of the teeth were normal except for the upper central incisors and all the canine teeth, which were very conical. The quality of the teeth was good and the caries incidence low.

Comparison of the permanent dentitions is difficult because of the wide difference in the age of the two boys (*Fig.* 4), but X-ray examination shows that thc clder boy has $\frac{6\,3\,1\,/\,1\,3\,6}{7\,6\,3\,/\,3\,6\,7}$; the younger boy has $\frac{6\,1\,/\,1\,6}{6\ /\ 6}$.

Presented at the meeting held on 11 Feb., 1963.

The elder brother began to suffer some indigestion when he was 10 years old, and therefore it was considercd wise to make him some dentures in an attempt to relieve this

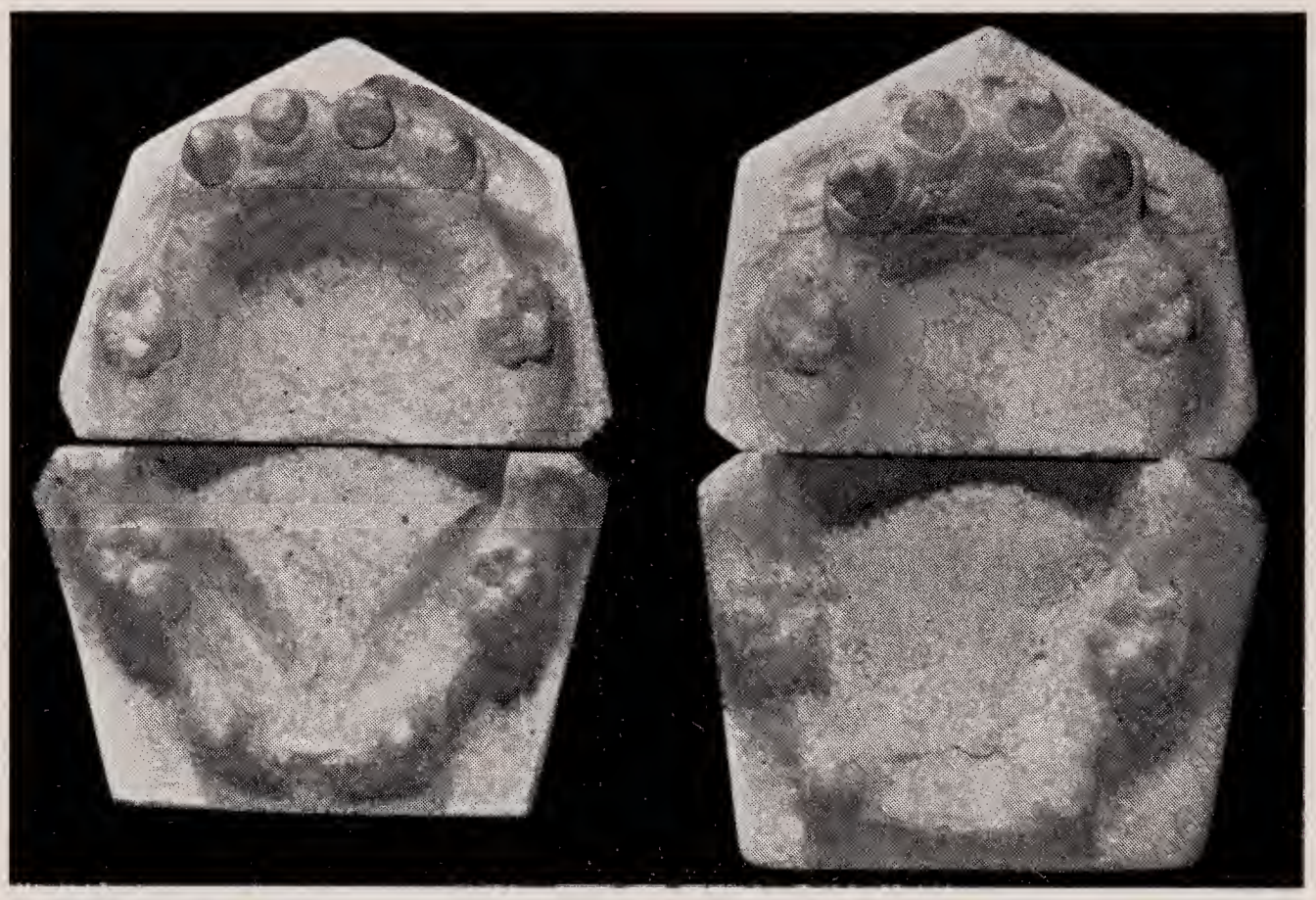

Fig. 2.—Models on left are those of elder brother, then aged 5 years. Models on right are those of younger brother, aged 3 years.

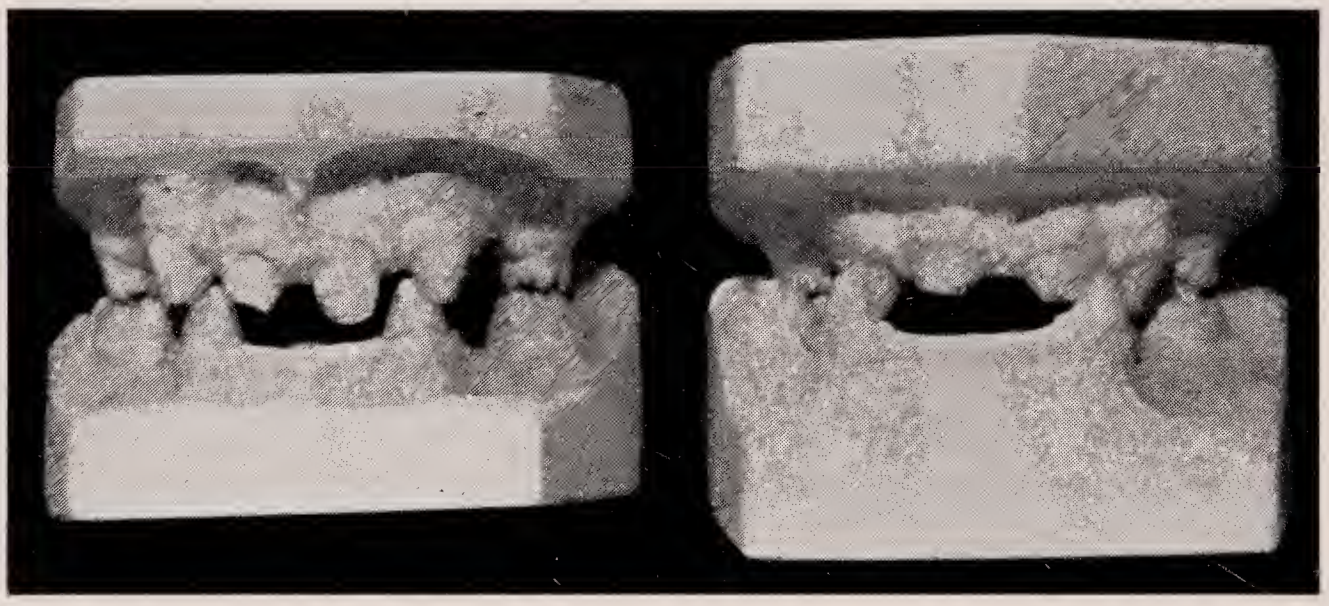

Fig. 3.—Models of elder brother, aged 5 years, to show bite in Class I relationship and models of younger brother, aged 3 years, to show bite pseudo-Class III, crossed on the right.

condition. During the last 5 years he has worn his dentures conscientiously and the indigestion has been eliminated. There is no sign of serious erosion on the occlusal surfaces of the second temporary molars, but the canine teeth have worn considerably, and this was observed at the age of 10 years before his dentures were fitted.

The same facts emerge in this case as were noticed by Mr. Leech, namely, that the mandible moves forward giving a mild Class III position, but this is exactly what happens in many full denture wearers and those with insufficient masticatory surfaces.

Bony development of the alveolus in the elder boy is very much less than in a normal child of his age and this can be directly attributed to his shortage of permanent teeth. There is no doubt that tooth development and eruption are a stimulus to bone growth.

The other children in this family are two girls who are identical twins aged 12 years. They both have a complete dentition in normal occlusion. The mother and father have no

dental abnormalities, but the mother has recently lost all her teeth and was fitted with immediate dentures.

whose dentitions are normal. The grandmother and her sister had a full complement of teeth, as far as can be remembered.

Fig. 4.—Models of elder brother at 5 years and 15 years, showing alveolar development.

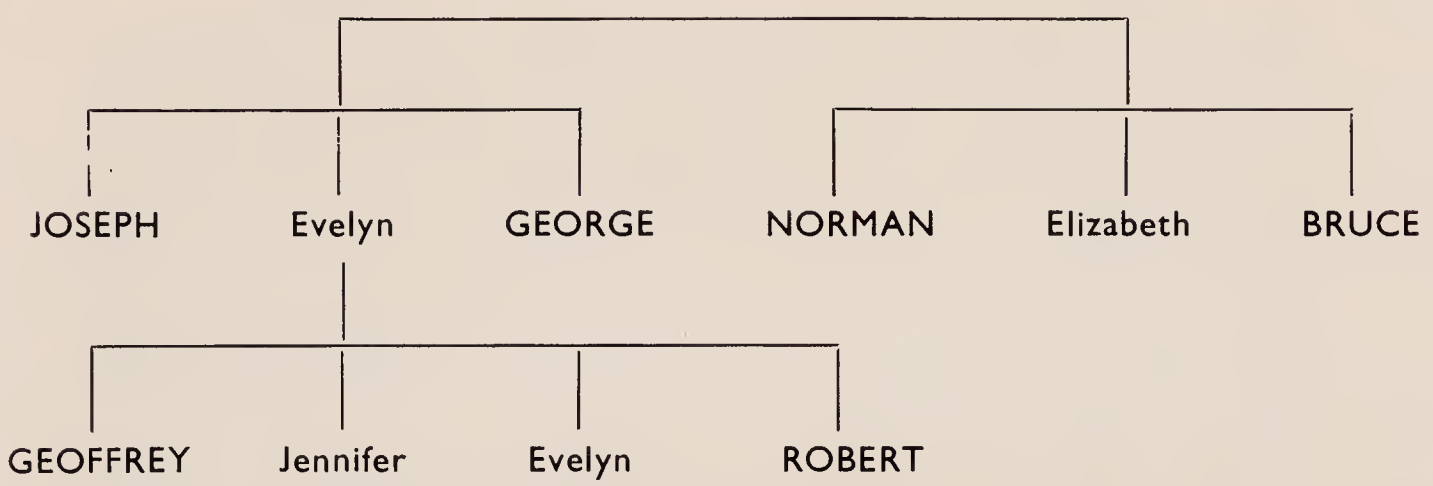

Fig. 5.—Family tree showing affected males in capital letters.

The absence of at least half the temporary and permanent dentitions in these boys is in itself a serious handicap.

Going back over three generations, this condition affects only the males, but it is transmitted by the females in a similar way to haemophilia (*Fig.* 5). The mother had two brothers and two male cousins who were affected in the same way as her sons. Of these, only the two brothers are living; one is unmarried and the other has two daughters,

Anodontia is a dominant sex-linked characteristic very similar in many respects to the recessive sex-linkage in haemophilia. The characteristic is undoubtedly borne in the X chromosome, and those which are in the X chromosome of the female are hidden by the normal allele.

Since the frequency of sex-linked anodontia remains roughly constant, it must be kept up through the origin of new anodontia genes by mutation.

In sex-linked inheritance the reciprocal crosses are, of course, not alike, but this exception is easily accounted for by the known behaviour of the sex chromosomes. Occasionally, however, reciprocal crosses are unlike because the offspring resemble in certain traits the female parent only, as though these traits are transmitted exclusively through the female gametes.

Such matroclinous inheritance can arise from either one of two causes.

First, it may be due to the characters concerned being inherited through the cytoplasm. The amount of cytoplasm in a female gamete is vastly greater than in a male gamete. Hence the mother is more potent in the transmission of such characters than the father.

Secondly, since the egg cell with its cytoplasm develops in the mother's body under the influence of the maternal genes, certain characteristics of the embryo, which arise from the egg, may be likewise influenced more strongly by the genes of the mother than by those of the father. This maternal effect is due to predetermination of the egg cytoplasm by the maternal genes.

All orthodontists have observed the congenital absence of certain teeth, often symmetrically, the most common being the upper lateral incisors, lower second premolars, and upper and lower third molars. It may be said that abnormalities of this kind affect some 5 per cent of the population of this country, but it is not often that there are more than four congenitally missing teeth in any one mouth. There seems to be a wide difference between small deficiencies of this kind and cases of complete or partial anodontia, although from a genetic point of view the causes would appear to be very similar.

In the course of my studies 8 cases of complete or partial anodontia have been investigated. All these patients have been males. Because of insufficient knowledge and lack of reports on this particular subject no claims can yet be made, but nevertheless it would be interesting to know if other members of this Society have shared my experience in noting that this deficiency appears to be confined to the male sex.

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DISCUSSION

The Chairman, in opening the discussion, said that he found cases of anodontia interesting from a research point of view because of the lack of vertical development.

Mr. E. K. Breakspear remarked on the very large space between the deciduous canine and the second deciduous molar. It would be interesting to know whether Mr. Ritchie had formed any theory why that particular spacing was so large.

Mr. T. Smith reported that he had had only 1 case of partial anodontia, and it was a male.

Mr. A. J. C. McIntosh said he had had 2 cases of partial anodontia in females, one of whom had six permanent teeth and the other eight permanent teeth. One of them had a very bad Class III malocclusion, and when he first saw her the only teeth that were in contact were the upper right lateral with the lower right lateral.

Miss R. Caseley asked Mr. Ritchie whether there was other evidence of ectodermal dysplasia in the cases of partial anodontia referred to.

Mr. J. C. Ritchie, in reply, said he agreed that the spaces between the temporary canine teeth and the second temporary molar teeth were certainly larger than the spaces occupied by the two first temporary molars. He did not feel that the teeth spread round the arch were necessarily in the positions in which one would expect to find them in a full dentition. As far as he could remember the teeth were spread evenly round the alveolus provided. He would be very interested to have details of any cases treated by members, because it was only by building up a composite picture of the abnormality that any real evidence could be obtained.

It was interesting to hear Mr. McIntosh say that he had had a case of a female who was affected, because it was the first such case of which he had heard.

So far as he knew, there was no other evidence of ectodermal dysplasia.

THE INFLUENCE OF CONGENITALLY MISSING TEETH ON THE ERUPTION OF THE UPPER CANINE

By B. H. MILLER, B.D.S. (RAND), D.ORTH. R.C.S. (ENG.)
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The upper canine, of all the teeth in the permanent dentition, develops farthest from the position it will finally occupy when fully erupted. It is therefore more prone to be diverted under various circumstances from its normal course of eruption.

The congenital absence of adjacent teeth, particularly the permanent lateral incisor, has a decided influence on the eruption of the lateral incisor. From here, it is guided downwards and distally, to erupt in the arch at about 12 years of age.

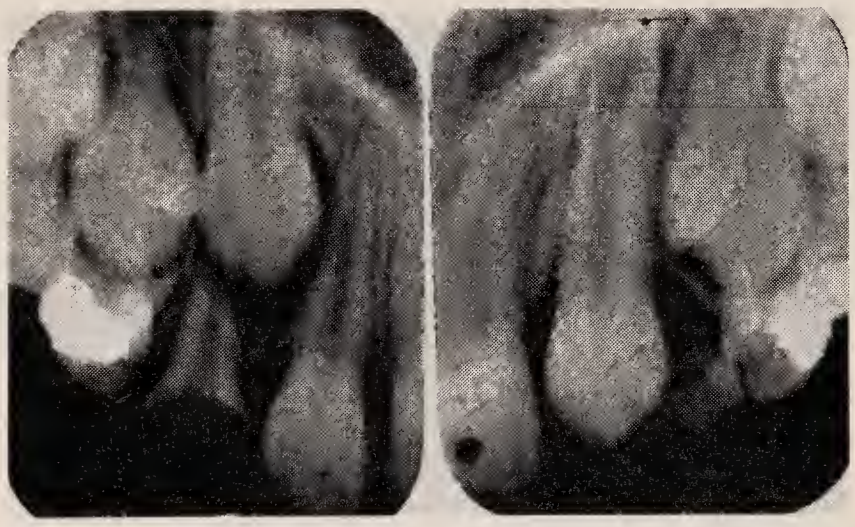
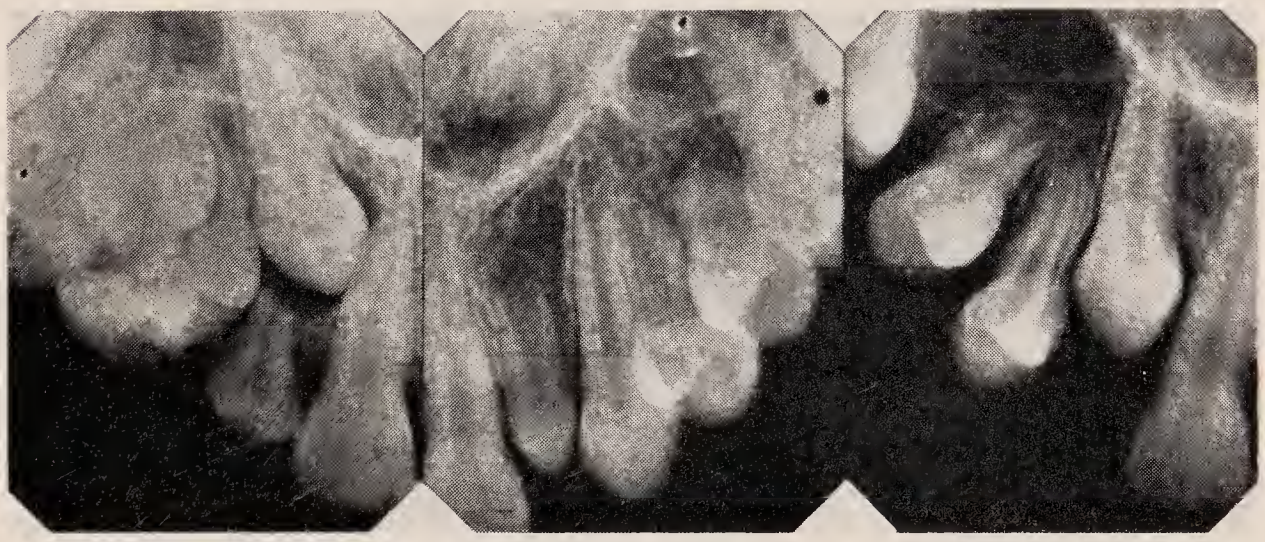


Fig. 1.—Patient F. S. Age 9½ years. Missing $\underline{|2}$. $\underline{|3}$ erupting before $\underline{3|}$.



A B C

Fig. 2.—A, B, Patient B. S. Age 11 years. Missing $\underline{2|}$, peg-shaped $\underline{|2}$. Eruption of canine delayed where lateral is missing. C, Showing eruption of $\underline{3|}$. Age 12 years.

Calcification of the canine germ commences in the first year of life immediately below the floor of the orbit. At this stage the maxilla is very shallow, with little or no antrum. At about 4 years of age, the canine moves labially, to occupy a position above and slightly buccal to the root of the permanent canine. A familiar situation arises, by virtue of the smaller root of the deciduous lateral incisor, allowing the canine to pass mesially over its apex, until it encounters the root of the permanent central. This tooth then takes over the role of the lateral, and the canine is guided down its distal surface to

Presented at the meeting held on 11 Feb., 1963.

erupt into the arch. However, this is by no means invariable, as will become evident in the following cases.

COMPARISON OF THE TWO SIDES

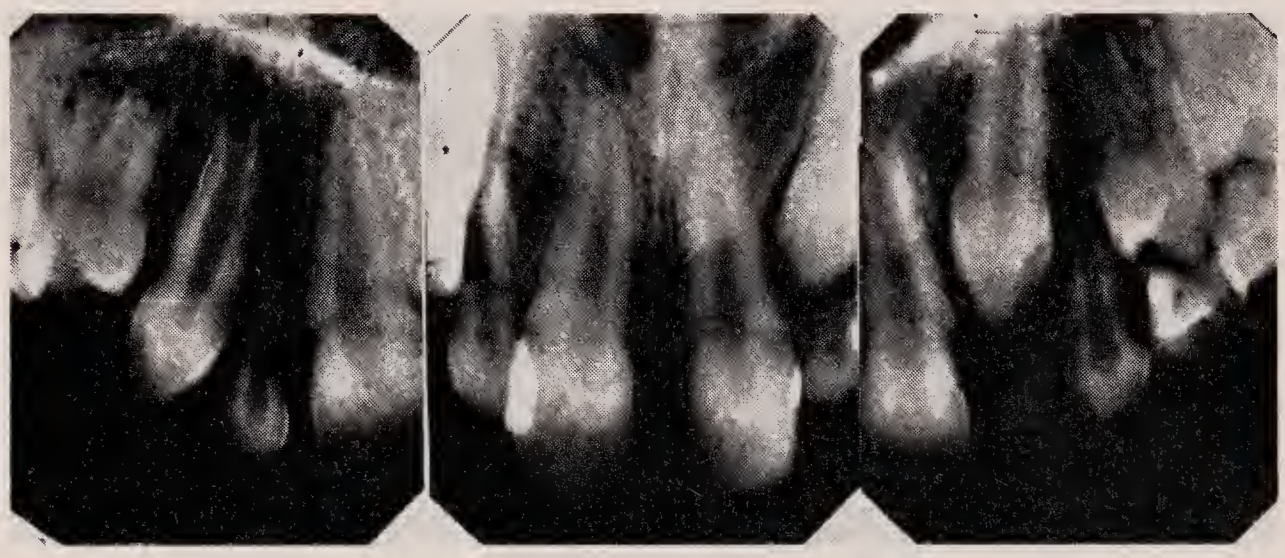
Comparison of the two sides (*Fig.* 1) where there is unilateral absence of the lateral incisor shows the canine on the affected side erupted at the age of $9\frac{1}{2}$ years, mesial to the retained deciduous canine and quite in advance of the normal side.

The same comparison (*Fig.* 2 A, B) shows the canine on the affected side slightly deviated towards the palate, while that on the other side, where a diminutive lateral is present, has already erupted.

Fig. 2 C, after extraction of the deciduous canine, and also the first permanent molar which was lost due to caries, shows an uprighting of the canine which is now erupting. It is quite possible that the canine could have become impacted in the palate had not space for its eruption been provided, in the manner described.

This variation between the two sides is also seen where there is bilateral absence of lateral incisors (*Fig.* 3 A). The canine on the right side is erupting distal to the deciduous lateral incisor, the root of which appears to be resorbed down its distal surface while, on the left, it has passed over the deciduous canine root, and is erupting adjacent to the central with an even transverse resorption of the deciduous lateral root.

In *Fig.* 3 B the canine is erupted on the right, but unerupted and medially inclined towards the central on the left, where the deciduous canine root shows abnormal resorption.



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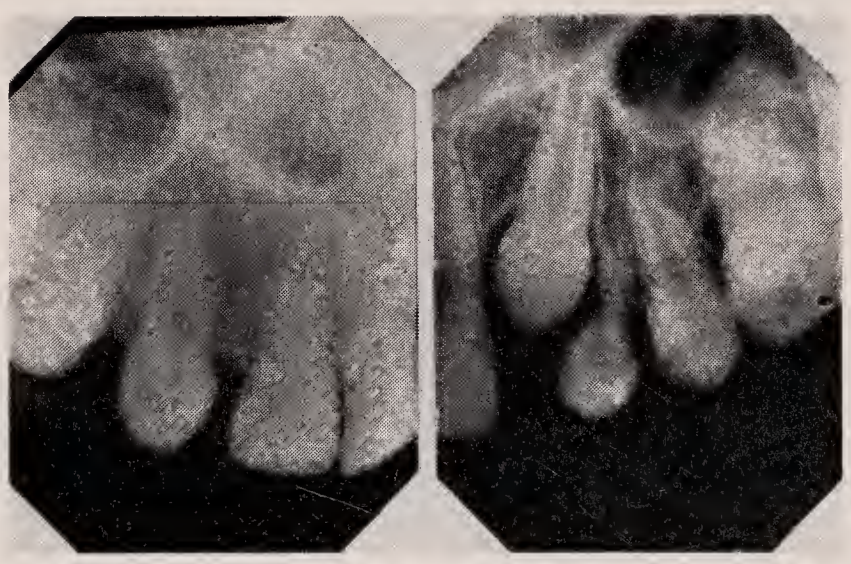


B

Fig. 3.—A, Patient M. T. Age $12\frac{1}{2}$ years. Missing $\underline{2|2}$. Differing time and path of eruption between left and right sides. B, Patient J. S. Age 12 years. Missing $\underline{2|2}$. Abnormal resorption of $\underline{|C}$ root.

CANINES IN THE PALATE

Not uncommonly, in association with missing laterals, one is presented with the problem of a canine in the palate. It is difficult to predict with any certainty when

this will occur, and why; where conditions for this to happen are fairly favourable, it does not occur more often.

The deciduous lateral is absent on the right (*Fig.* 4) where the canine has become deflected into the palate. The deciduous canine is not resorbed. On the other side there is a diminutive lateral and the canine is erupting normally.

Fig. 4.—Patient A. P. Age 11 years. Missing $\underline{2|}$, peg-shaped $\underline{|2}$. Deflexion of $\underline{3|}$ into palate.

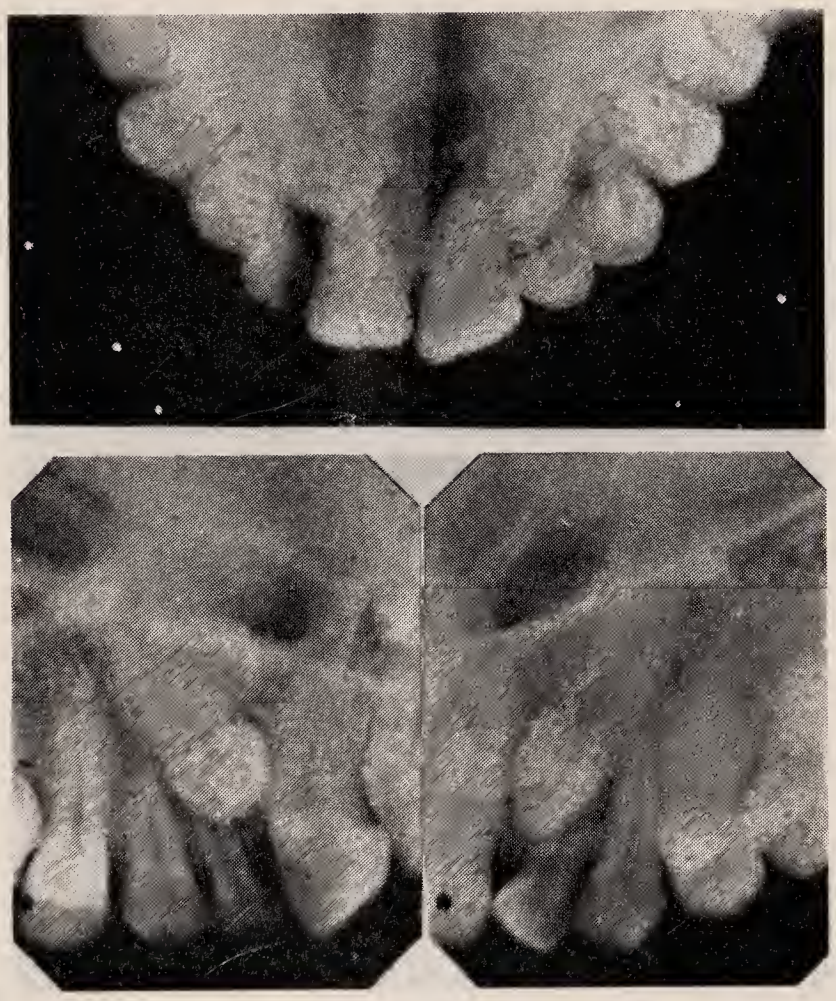


Fig. 5.—Patient D. C. Age 16 years. Missing $\underline{2|2}$. Deflexion of $\underline{3|}$ into palate.

In *Fig.* 5 the canine on the right is also palatally displaced, but both deciduous lateral and canine are present and unresorbed. Forward movement of the buccal segments, leading to 'crowding of the canine', would therefore not be an important factor in this case.

Fig. 6 illustrates a case where both deciduous lateral incisors are absent. The right canine is in the palate and the deciduous canine roots are obliquely resorbed.

This oblique resorption of the deciduous canine root is, as has been shown, frequently, but not invariably, evident where the canine has taken a mesial course and would seem to be secondary to its abnormal position. However, once this abnormal resorption has

commenced, shedding of the deciduous tooth may be delayed, leading to further deterioration of the position of the canine.

Much more rarely (*Fig.* 7) does one see resorption of the roots of the central incisors which, if not intercepted early, can lead to a rather disastrous situation. The canines were 'pinned' in this case, and then mechanically moved into the arch after extraction of the deciduous canines. The central incisors, although badly resorbed, are still vital and functional many years later.

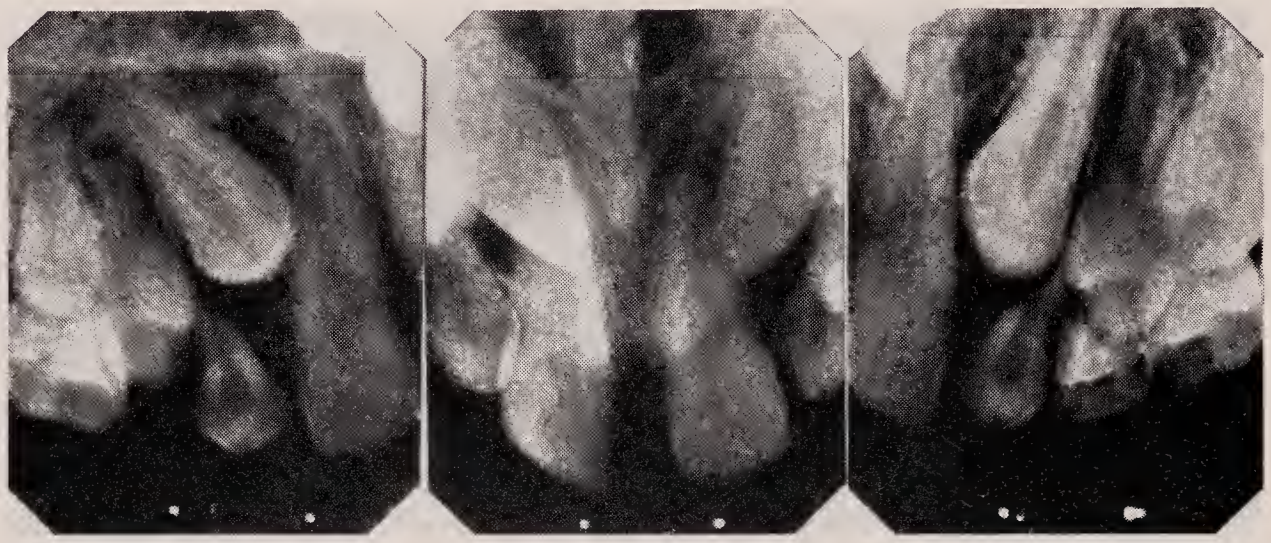


Fig. 6.—Patient T. B. Age 12 years. Missing $\underline{2|2}$. Deflexion of $\underline{3|}$ into palate. Oblique resorption of $\underline{C|C}$ roots.

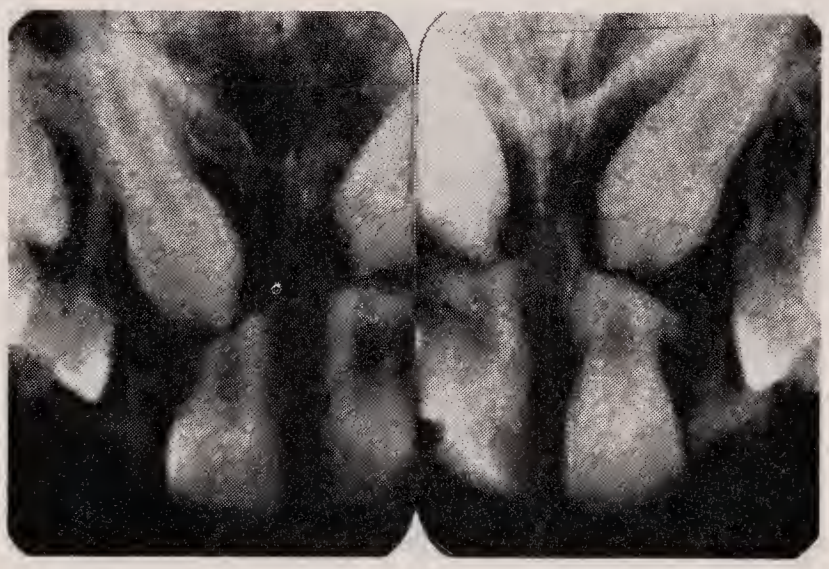
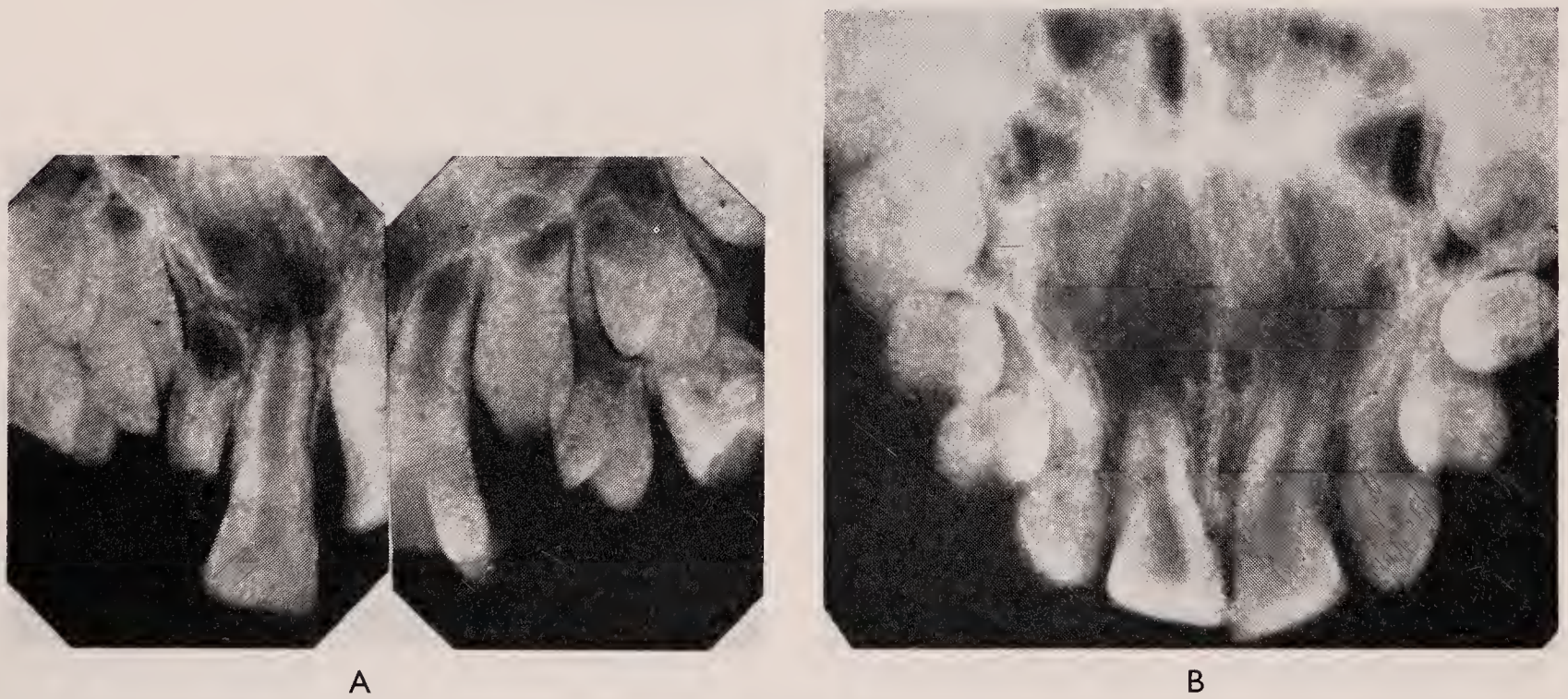


Fig. 7.—Patient C. W. Age 11 years. Missing $\underline{2|2}$. $\underline{3|3}$ resorbing roots of central incisors.



A B

Fig. 8.—A, Patient K. E. Age 9 years. Invaginated $\underline{2|2}$ preventing eruption of $\underline{|1}$. B, Age 13 years. $\underline{3|13}$ erupted satisfactorily after removal of 'odontomes'.

EARLY EXTRACTION

Early extraction of deciduous teeth would seem a wise precaution, providing there are no other contra-indications, especially where it is noted that the canine is ready 'off-course'.

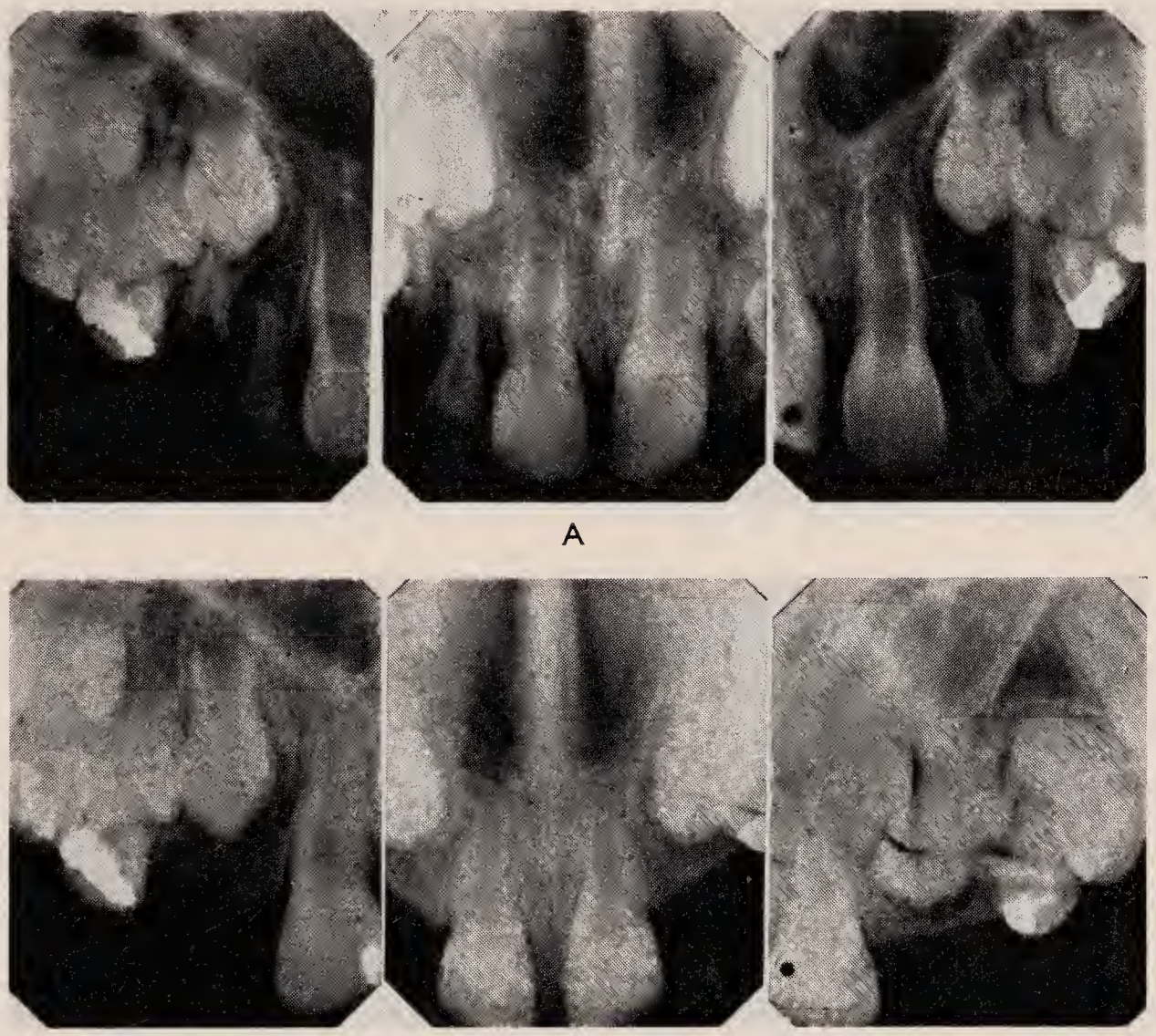
The radiographs in *Fig.* 8 A illustrate a case where invaginated lateral incisors are preventing eruption of the canine and the left central incisor.

After their extraction (*Fig.* 8 B) the canine on the right has come forward and erupted with a satisfactory axial inclination, followed by the buccal segments.

Extraction of deciduous lateral incisors and canines on both sides was carried out at $6\frac{1}{4}$ years of age (*Fig.* 9 A). At this stage, the canines were fairly high in the alveolus in relation to the apices of the central incisors and had already moved mesial to the roots of the deciduous canines.

At nearly 7 years (*Fig.* 9 B) the canines had erupted a fair distance in a satisfactory direction.

This case is an Angle Class II, division 1 malocclusion, and it is possible, once eruption of the canine has been established, to retract the central incisors, and then allow forward movement of the buccal segments to close residual spacing, should this prove necessary. Treatment would therefore be complete, after



A

B

Fig. 9.—A, Patient L. G. Age $6\frac{1}{4}$ years. Missing $\underline{2|2}$. B, Age 7 years. $\underline{3|3}$ erupting following extraction of $\underline{CB|BC}$.

eruption of the premolars, with no necessity to restore the missing laterals.

If extraction of deciduous teeth is carried out early enough, the undesirable necessity of artificial restoration at an early age, or the difficulty of space closure in the complete permanent dentition, may be avoided.

As mentioned previously, this is not always a desirable course of action and, in any event, the patient often presents at a later age when a pattern has already been established.

CONGENITALLY MISSING PREMOLARS

A case presenting at 5 years, with absence of deciduous and permanent lateral incisors, and a diastema between the deciduous and the

unerupted permanent central incisors is illustrated in *Fig.* 10 A.

The upper first premolars are missing as well as the lateral incisors (*Fig.* 10 B) and at 13 years of age (*Fig.* 10 C) the canine on the right is erupting in the premolar position, the second deciduous molar on the right and the first permanent molar on the left (*Fig.* 11 B).

Her brother has a supplemental lateral on the same side (*Fig.* 12 A) and is without only the second premolar on the left and both on the right, where the pattern is quite similar to

A B C

Fig. 10.—A, Patient R. D. Age 5 years. Missing $\underline{B|B}$ and $\underline{2|2}$. B, Age $9\frac{1}{2}$ years. Missing $\underline{4|4}$ (as well as $\underline{2|2}$). C, Age $13\frac{1}{2}$ years. $\underline{3|3}$ showing slightly different paths of eruption.

while on the left it has followed a more mesial course, despite the space made available by the missing premolar.

Two cases, a brother and a sister, with numerous missing teeth, who both have supplemental lateral incisors, are shown in *Figs.* 11 and 12.

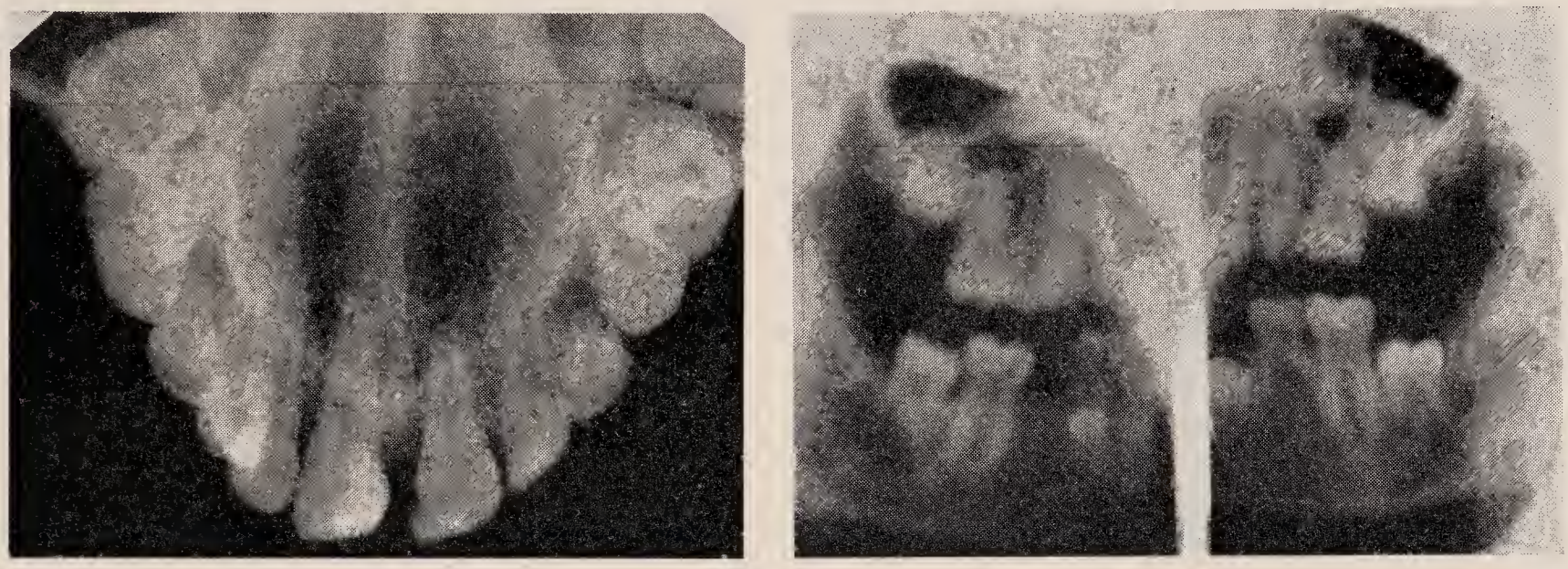
The girl is without all the upper premolars on both sides and has a supplemental right lateral incisor. The canines have erupted at about 8 years of age (*Fig.* 11 A), with a marked distal inclination, distal to the deciduous canines, in contact with and overlapping that of his sister (*Fig.* 12 B). Two younger brothers also exhibit partial anodontia, as does the mother.

TRANSPOSITION

Fig. 13 depicts a case where the lateral is missing on the left, the canine is bodily superimposed on the first premolar, and both are distal to the deciduous lateral incisor and canine. There is a diminutive lateral on the right, where the first premolar apex is displaced well forward over the deciduous canine root and the canine apex distally.

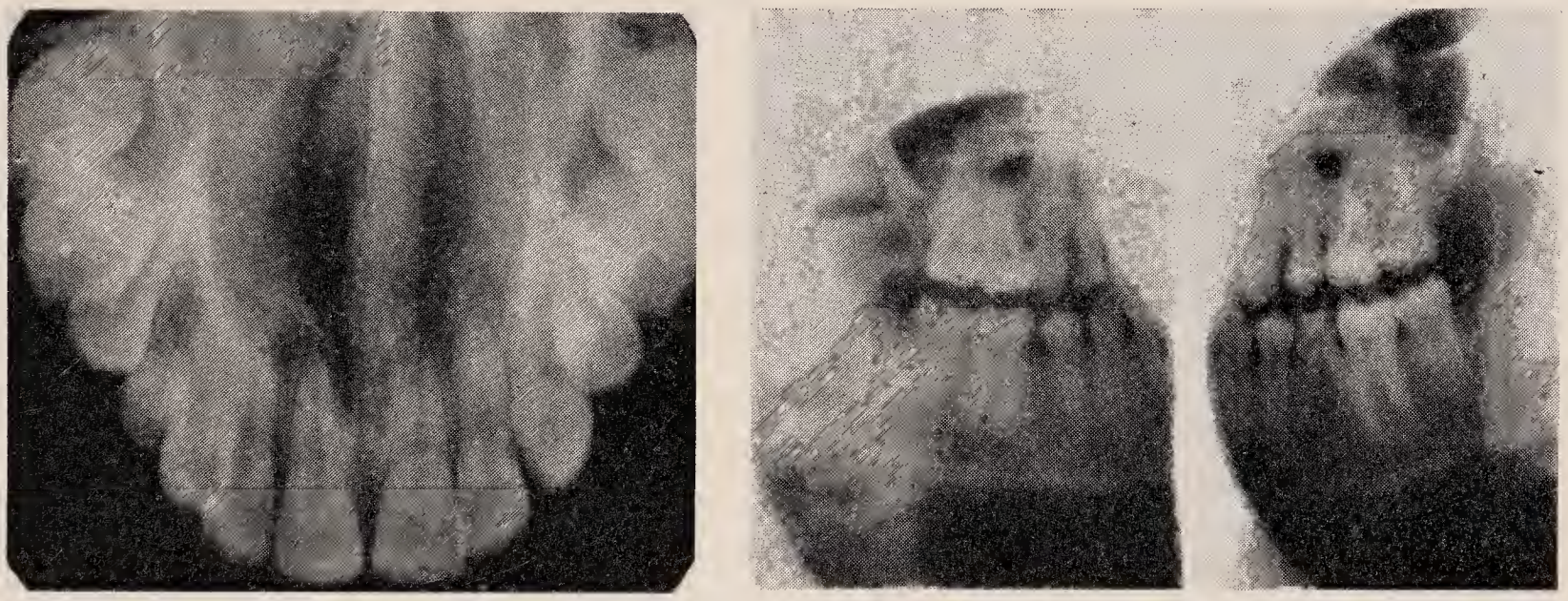
In *Fig.* 14 there are two diminutive laterals and superimposition of canine and first premolar on the left, both being distal to the deciduous canine. Eruption on the other side is normal.

It has been suggested that defective or missing laterals are in some way instrumental in the aetiology of transposition. However, in view of the fact that the canine tends to find its way forward in these circumstances,



A B

Fig. 11.—A, Patient L. W. Age $8\frac{1}{2}$ years. Supplemental $\underline{2|}$. B, Age $8\frac{1}{2}$ years. Missing $\underline{54|45}$. $\underline{3|3}$ erupting with a distal inclination.



A B

Fig. 12.—A, Patient R. W. Age $13\frac{1}{2}$ years. Supplemental $\underline{2|}$. B, Age $13\frac{1}{2}$ years. Missing $\underline{54|5}$. Distal eruption of $\underline{3|}$.

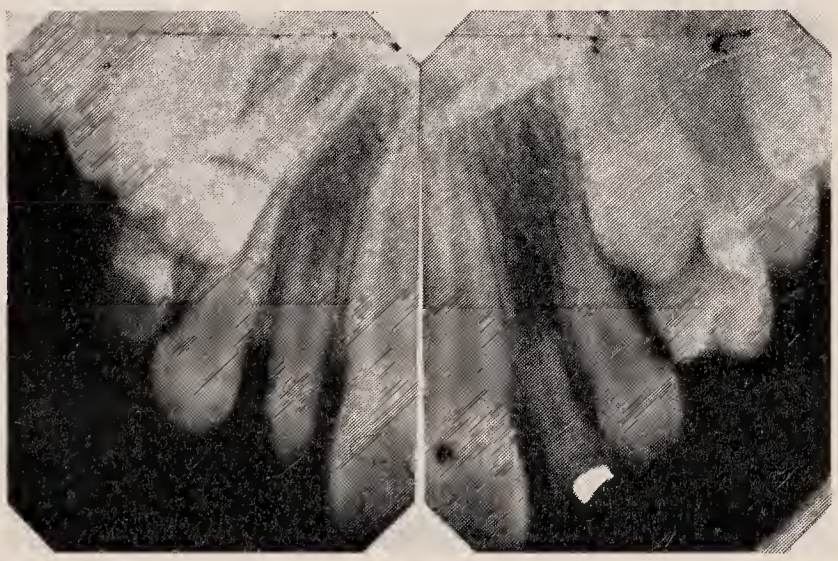


Fig. 13.—Patient S. H. Age $11\frac{1}{2}$ years. Missing $\underline{|2}$. Peg-shaped $\underline{2|}$. Transposition of $\underline{43|34}$.

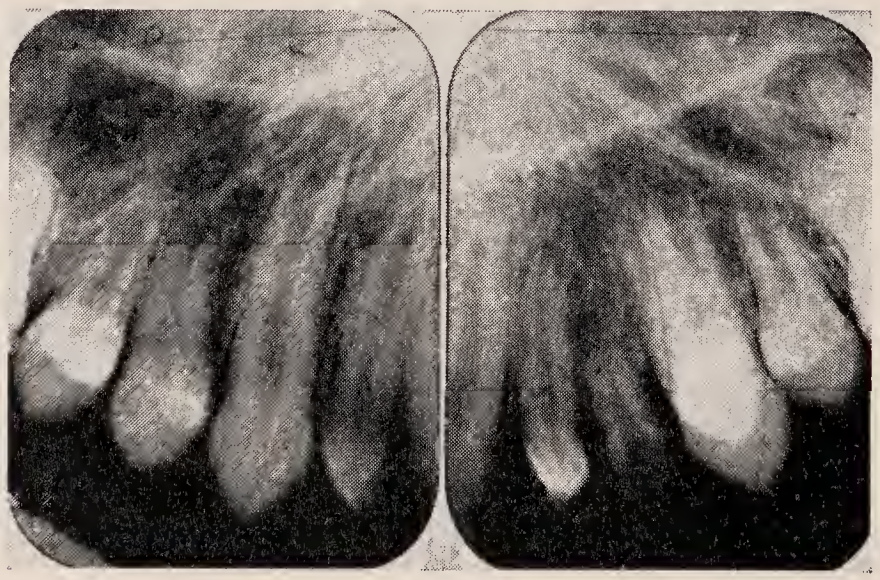


Fig. 14.—Patient J. S. Age 12 years. Diminutive $\underline{2|2}$. 'Partial' transposition of $\underline{|34}$.

this does not provide a very likely explanation, and could well be a mere coincidence. The root of the deciduous canine would, if anything, provide an obstacle to forward movement of the first premolar, and yet in the first case shown, where both deciduous lateral and canine were present with good roots, the premolar was still in a forward position.

Ectopic developmental positions of the canine and first premolar would still seem the best theoretical cause of the anomaly until it is possible to obtain serial X-rays of these cases from a very early age. However, abnormal positions of tooth germs could be more prevalent in cases of partial anodontia.

In the early stages of development the canine lies partly above the deciduous first molar and first premolar in the small crowded jaw. A canine crypt, placed slightly distal to its normal position, or a canine developing with a distal inclination, could lead to its deflection down the distal surface of the deciduous canine root and to its being superimposed on the premolar, as in the cases shown.

If the first premolar is in a developmentally forward position, the erupting canine on encountering it could be deflected distally, at the same time forcing the premolar farther forward.

Conversely, a canine erupting ectopically could force the premolar mesially, at a stage where it lies above the roots of the deciduous molar.

CONCLUSIONS

It would appear that the canine will take the 'path of least resistance' wherever teeth are missing. However, in the group where lateral incisors are absent there is a further uncertainty as to which path it will take, and therefore at what age it will erupt. The roots of the peg-shaped lateral incisors are usually of adequate length to guide the canine on a normal course.

In the small number of fifty cases surveyed, small arches and early loss of deciduous lateral incisors, with forward movement of the buccal segments, were often, but not invariably, associated with mesial deflexion and delayed eruption of the canine.

I would suggest that its developmental position and axial inclination, as well as the presence of deciduous teeth, which might deflect it off its course, or their absence, or a combination of these factors, are significant in determining the eventual path of eruption.

Acknowledgements.—In conclusion, I would like to express my appreciation to Mr. B. C. Leighton and Mr. M. A. Kettle for their encouragement and advice, and to Mr. Kettle and Mr. H. E. Wilson, of the London Hospital, for permission to use their cases.

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DISCUSSION

Mr. C. P. Briggs asked, in view of the apparent influence of the permanent lateral incisor, rather than the deciduous canine, on the erupting permanent canine, whether the author, when undertaking a serial extraction technique, preferred to extract the upper first deciduous molar or the upper deciduous canine.

Mr. L. H. Russell asked whether the author had noticed any correlation between congenitally missing upper lateral incisors and lower second premolars.

Mr. E. J. R. Bird asked in how many of the fifty cases were the canines palatally placed.

Mr. H. E. Wilson said it would seem that Mr. Miller was, in effect, comparing X-rays in some cases which should not have been compared. The difference in the position of the tooth might have been accounted for by the direction of the X-ray.

Mr. B. H. Miller, in reply, said that on the question of whether he extracted deciduous canines or first molars, he did practise the extraction of deciduous molars. However, the situation was obviously altered when the laterals were absent, and it was also unlikely that the first premolars would be extracted.

As to the correlation between the missing 2's and 5's, one often came across such situations, especially as these were the two most common sites of congenitally missing teeth. He could not say what was the exact percentage of cases in which this occurred.

With regard to how many canines there were in the palate, he had shown three consecutive cases of such a type, and there were six such cases in the series.

He had felt that someone would bring up the question of the X-ray technique not being standardized. It was not meant to be a scientific survey, but rather a selection of cases, and he assured Mr. Wilson that he could back most of the cases up clinically.

THE INFLUENCE OF CRANIAL BASE STRUCTURE ON THE ORIENTATION OF THE MIDDLE THIRD OF THE FACE

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MANY anthropological investigations have led to the description of types or classes of the human face. The cephalic index is an example of such a classification and it is useful in the distinction of cranial shapes in relation to racial groups. Similarly, facial profiles have been described as retrognathous, orthognathous, and prognathous, and, again, as a very general method of grouping, such a classification has value.

When the same kind of system is applied to the classification of the relationship of one part of the face or jaws or set of teeth to the other, difficulties arise in so far as individual variations enter into the picture. Although the general configuration of a person's face may place it and the associated dental occlusion within a certain type, this does not necessarily imply that all others of that type will take the same route to arrive at the same general appearance.

That there is much variation in proportion between individuals is well known, and, of course, this fact makes it possible to recognize persons by their facial appearance better than by any other aspect of bodily shape or size. However, no matter what the size or individual relationships of parts that may be established, the essential sites of growth are the same for each face. It is variations in the direction of growth and size in the parts, both in prenatal and postnatal life, that can lead to the development or exaggeration of a facial malrelationship or determine the individual facial appearance.

Scott (1955) further states that it is difficult to estimate by the use of measurements the extent or location of any dentofacial abnormality. It would be useful, however, to know the varieties of facial pattern within which abnormalities of the occlusion occur. This would appear to be the most valuable contribution that could be made to orthodontics by learning more about the constitutional variations in facial form. Berger (1938, 1940) has already done some work along these lines, and it is the purpose of the following study to follow the same path and to determine if any parts of the face or cranium, either individually or in combination, have an excess or deficiency or particular relationship one to the other in certain observed types of facial make-up. Attention has been concentrated on the middle third of the face and the cranial base in the vertical and anteroposterior planes of space.

Personal observation of many children and adults over the years has led to the arbitrary description or classification of two types of face: One where the middle third appears to be retrusive and which is associated principally with a reversal of normal incisor relationship and often a reduction in the vertical overlap of these teeth; the other, the reverse of the first, where there appears to be a protrusive middle third and associated maxillary prognathism.

Up to now such a classification has been entirely subjective, and it is one of the purposes of this investigation to determine to what extent subjective observation is supported by actual measurement. For the purpose of comparison an equal number of controls consisting of children with good facial balance, as determined by acceptable occlusion of the teeth and general appearance, have been subject to the same measurements.

In order that the possible part played by the elements of the cranial base and face to be measured may be considered in perspective, an outline of facial growth as at present understood for the purposes of this investigation will be given.

Presented at the meeting held on 11 March, 1963.

FACIAL AND CRANIAL GROWTH

In studies on human growth limited means are available and serial studies on postnatal material can only rely upon external or radiographic measurements. The examination of post-mortem material cannot be a reliable source of knowledge since individuals will reach the same developmental horizon at varying chronological ages.

Animal studies, using such aids as vital staining, have been employed, but here care must be taken in transferring the results and applying them to human growth. Scott (1958) has pointed out a fundamental difference between the cranial base growth of monkeys and most other animals and man. This is to be found in the persistence of the presphenoid and postsphenoid synchondrosis in animals after birth but which, in man, unites just before birth. Growth here in animals, which is in the same plane as the pterygopalatine sutures, will allow the backward growth of the maxilla to occur, of which evidence was found by Brodie (1941), using vital staining. This persistent cranial base growth may also be responsible for suture growth as shown by Sicher (1949), at the frontomaxillary, zygomaticotemporal, zygomaticomaxillary, and pterygopalatal sutures. Suture growth will be also related to the persistence of the growth of the cartilage of the nasal septum in animals and will explain the evidence found by Brash (1924). Furthermore, Diamond (1946) found that the maxillary tuberosity lay external to the pterygoid process in children's skulls, and this would tend to discredit the theory that surface growth on the posterior aspect of the maxilla gives a forward resultant to that bone by pressure on the pterygoid processes.

In man, therefore, it would seem necessary to postulate a different method of postnatal facial growth from that found in experimental animals, but some mention will be first made of the prenatal establishment of the position of the maxilla in relation to the cranial base.

Scott and McKeag (1956) state that facial form, in foetal life especially, is closely determined by cartilage growth. Changes that occur in the cranial base that will affect maxillary position are those of growth and angulation. It is well known that a gradual opening of the angle between the anterior and posterior limbs of the cranial base occurs in foetal life. Ford (1955), Gordon (1957), and Scott (1958) have examined this and the average alteration in angle takes the form of an increase from 130° to 150° between the 10th and 40th weeks. This change will help to carry the face upwards and forwards. In animals in which the pre-postsphenoid synchondrosis persists, this opening can continue after birth, for Scott (1958) believed that the change in angulation occurs in the region of the body of the sphenoid.

Growth in length of the cranial base will also project the face forwards from the region of the foramen magnum, and in this connexion the cartilaginous nasal septum must be included amongst the cranial structures. The synchondroses between the basioccipital and the sphenoid, the presphenoid and postsphenoid, and the sphenoid and ethmoid will all contribute to the increase in cranial base length in prenatal development.

To the anterior limb of the cranial base is attached the nasal capsule consisting of the central septum and two lateral parts. Upon this cartilaginous foundation, the membrane bones of the facial skeleton are laid and the cartilage of the capsule, by its growth, will contribute to the size to be attained by the maxilla.

In man, at birth, the pre-postsphenoid synchondrosis is no longer active, and between the ages of 1 and 3 years, according to Scott (1958), ossification of the cribriform plate stabilizes the upper part of the nasal cavity, thus limiting growth in the associated craniofacial suture system. Of the synchondroses remaining in the cranial base, Ford (1955) has shown that activity at the sphenoethmoidal is present up to the seventh year. This would accord with the finding of de Coster (1952), who found very little change in the anterior cranial fossa after the seventh year. At this time also, the cranial and orbital cavities have reached almost adult size, according to Scott (1954). By this time, too,

the nasal septum has made its major contribution to the downward and forward positioning of the maxilla. The importance of this structure in this aspect of growth has been noted by Applebaum (1953) and Scott (1954).

By the age of 7, therefore, the only synchondrosis which will have any tendency to increase cranial base length and to project the middle third of the face farther forwards will be that between the sphenoid and the basi-occipital. This persists in activity through adolescence according to Abbie (1950) and Ford (1955).

As it would seem that growth at sutures will only occur in response to some external force separating them, such as the growing orbital contents or brain and the cartilage of synchondroses or of the nasal septum, it becomes necessary to find some means by which facial growth is able to occur after the age of 7 years when these mechanisms, apart from the spheno-occipital synchondrosis, are no longer operative. A very considerable amount of increase in height and depth is still to be achieved, and some structure must be present to organize this growth in direction and amount.

Keith and Campion (1921) considered that growth in the upper face determined the total amount of facial increase in height and depth. Schour and Massler (1943) and Hellman (1935) considered that the force of eruption forced the jaws apart. More recently, however, Diamond (1944) called the ramus of the mandible the pace-maker of vertical development and Walpole-Day (1951) considered that the total increase in mandibular height took place from the condyles, but still held the view that the maxilla grew independently, the mandible keeping pace with it.

In the case of the maxilla, Scott (1948) and Brash (1924) came to the conclusion that later growth was due entirely to the surface deposition of bone. Now, the increase in size of a bony structure by surface deposition can only occur if room is made available for the greater amount of bone. In the case of facial growth, this can readily be achieved by the downward and forward growth of the mandible by the proliferation of the condylar cartilage. As increasing separation is brought about between the maxilla and the mandible by this means, surface deposition in the maxilla will increase the size of that structure in a direction parallel to mandibular growth. As

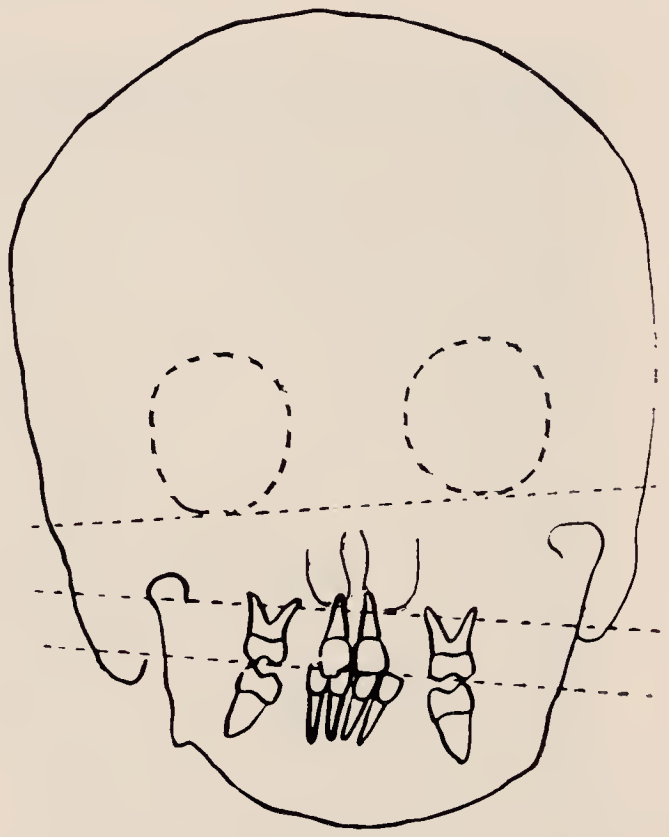

Fig. 1.—Hypoplasia of one condyle head showing the reduced height of the nasal cavity and reduction of maxillary height on the affected side.

the maxillary bone tends to increase in bulk, so does internal resorption remove unwanted bone, resulting in the increase in size of the maxillary sinus. At the same time, nasal cavity height will increase by the same process. Not all the space between mandible and maxilla will be filled by maxillary growth, but similar deposition will occur on the mandibular alveolar process, increasing the height of the body of the mandible. Room for the posterior maxillary teeth will be made as the upper arch increases in length, owing to the forward component in the pattern of surface deposition carrying the upper teeth farther away from the posterior aspect of the maxilla.

Evidence of the influence of the growth of the mandibular condyles upon facial proportions may be found in the examination of cases of either hypo- or hyperplasia of one condyle. In the former (*Fig.* 1) reduced upper face (including nasal cavity) height may be seen, and in the latter (*Fig.* 2) the reverse effect is noted.

From the previous discussion it may be fairly stated that many factors would influence the original positioning and size of the maxilla

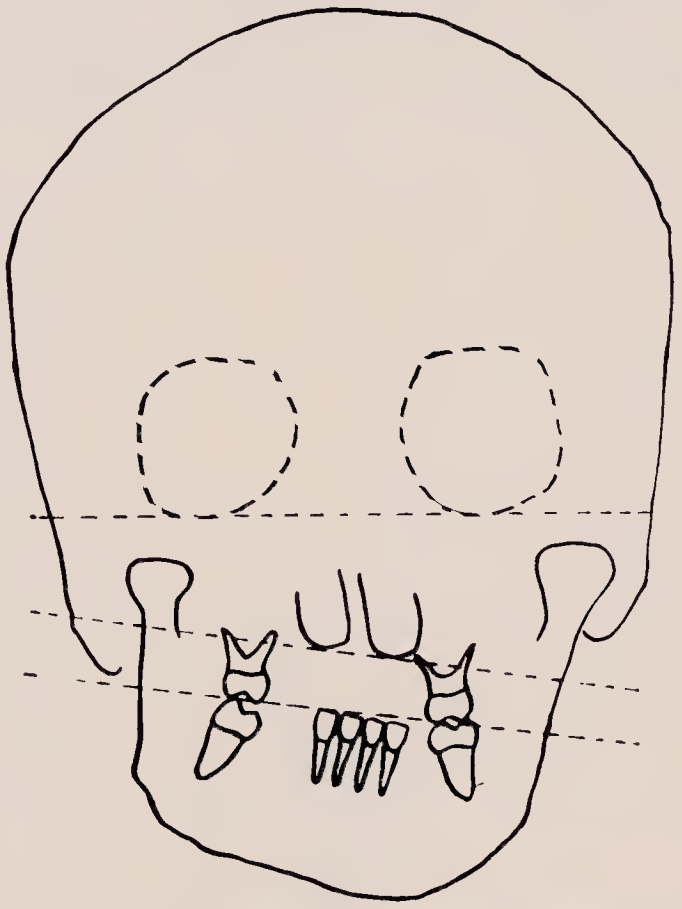

Fig. 2.—Hyperplasia of one condyle head showing increased height of the nasal cavity and the maxilla on the affected side.

in the craniofaeial complex. Some of the most important of these occur in prenatal life and are related to the following factors:—

1. Cranial base angulation.

2. The length of the cranial base limbs, i.e., from the foramen caecum to the body of the sphenoid and from there to the basi-occiput.

3. The size of the cartilaginous nasal capsule.

After birth, up to the seventh year, the amount and direction of growth of the cartilage of the nasal septum plays an important part.

If, therefore, any differences are to be found in the size of the cranial base structures in individuals with different facial patterns, these differences will be established by about 7 years of age.

THE INVESTIGATION OF CRANIO-FACIAL PROPORTIONS

The Material.—It was desired to concentrate interest chiefly upon the middle third of the face and the cranial base, and the greater part of the investigation has been carried out on two types of face. The subjects were chosen by prior clinical examination as presenting the following conditions.

Small Middle Third (*Fig.* 3).—

1. *General facial appearance*:—

a. Soft-tissue profile showing retrusion of the middle part of the face evidenced mainly by a lack of fullness in the upper lip. The kind of appearance in these patients almost parallels the appearance of a person suffering from a depressed fracture of the middle third.

b. In full face the flattening of the upper lip is still seen, and there also appears to be some lack of bony support to the ala-base, as evidenced by an excessive hollow in this region.

c. There is a relative fullness of the lower lip related to (*a*) and (*b*) above.

2. *The occlusion and jaws*:—

a. The upper incisor teeth will be found to be in either an edge-to-edge relationship with their lower opponents or some or all of them to occlude behind.

b. The upper incisors are crowded due to lack of intercanine width and the upper arch as a whole is narrow and cramped.

c. Consequently, the buccal cusps of the upper cheek teeth may be found to occlude on one or both sides on the lingual aspect of the corresponding cusps of their lower opponents.

d. Subjects were omitted if they showed any sign of undue mandibular size, as evidenced by excessive room for the mandibular teeth. This was done because it is the intention to investigate the percentage of upper-face height to lower-face height, and it was felt that the inclusion of subjects with excessive mandibular size would give an incorrect representation of the value and destroy the purpose of this part of the investigation, which was to examine a reduction in the middle third only.

Large Middle Third (*Fig.* 4).—

1. *General facial appearance*:—

a. Soft-tissue profile showing a fullness of the maxillary region and upper lip not due to an obvious labial tilt of the upper incisors.

b. In full face, no obvious reduction in the lower part of the face related to the mandible

which may have given the effect of an upper-third fullness.

2. *The occlusion and jaws*:—

a. The upper incisor teeth will be found to be in advance of their lower opponents, but not by reason of being tilted in a labial direction to any obvious extent.

b. The whole upper arch well formed and with adequate or excessive room for all teeth.

c. Some tendency for the buccal cusps of the upper teeth to lie somewhat more buccal to those of their lower opponents than is usual. Frequently the first premolars were found completely outside the lower arch.

Fig. 3.—Facial appearance and underlying jaw structure of the small middle third type of face.

Fig. 4.—Facial appearance and underlying jaw structure of the large middle third type of face.

d. Subjects were omittcd if they showed any sign of mandibular insufficiency as evidenced by crowding of the lower teeth. This was done for the same reason as in the case of the small middle third.

Age of the Subjects.—The chief criterion as far as age was concerned was that the subject should be at least old enough to havc reached the stage of cranial and facial growth when, as far as is known, the significant contribution of cartilage to the middle third of the face has been achieved, according to Scott (1954). The greater number of subjects are between the ages of 10 and 14 years. The tremcndous variation that exists between individuals would seem to make it unnecessary to confine the investigation to any particular age-group.

The Method of Assessing Age.—As children reach developmental horizons with considerable variation in respect of chronological age, it was decided to age the subjects using the development of the dentition as the criterion. This is after the method of Hellman (1927), and based on the work of Schour and Massler (1941).

There were forty in each of the two categories of facial type chosen and, in addition, an equal number of controls in the form of subjects with clinically correct occlusion. These latter were arranged in age-groups as already described.

The Method of Investigation.—Lateral head X-rays were taken in the head holder of the orthodontic department. This holder had been designed so that the sagittal plane is placed at a constant distance from the film. This arrangement was particularly fortunate, in that the greater part of the measurements carried out on the head plates were of structures in the midsagittal plane. This would tend to cancel out errors due to magnification had the ear plug nearest to the film been of the fixed type.

The only measurements carried out involving structures in another plane were those relating to the distance of the molar teeth from base lines in the upper and lower jaws respectively.

The placing of the midsagittal plane at a constant distance from the film and anode is in accordance with the recommendation of Hallett (1959) in a recent review of errors in cephalometric films.

Method of Correction used in Present Investigation.—An experiment was conducted to discover the degree of enlargement of the particular cephalometric arrangements used. A special ruler was made using lengths of stainless steel wire as radio-opaque markers. These were placed at millimetre intervals by superimposing them upon the lines engraved on a standard ruler. Exposures were made of this ruler in certain positions, bearing in mind the position on the films of the landmarks to be measured. In the midsagittal plane, the ruler was placed at the transmeatal axis, that is, at central ray level and also at 2 cm. and 9 cm. above, corresponding to the average distances out from the central ray of some of the landmarks. Further exposures were made nearer to the film from the midsagittal plane by the average of half the width of an arch in the molar region. Two exposures were taken 4 and 5 cm. respectively above the height of the central ray. Examination of the images of the ruler showed no difference in any of those taken in the midsagittal plane and no difference between the other two taken to represent the molar region. There was, as may be cxpected, some difference between those taken in the midsagittal plane and those taken nearer to the film.

In view of these findings, two conversion tables were made so that readings, taken directly off the film with a millimetre ruler, could be converted to their true value in millimetres (*Fig.* 5). This procedure was adopted for two reasons. First of all, it was convenient to use the millimetre scale on the draughting machine fixed to the tracing desk directly on the films rather than to use dividers and then to read off from the enlarged scalc.

Secondly, as some of the measuring points used in the investigation arc either geometric constructions or at the intersection of two lines, it was decided to mark all points directly upon the films with a fine pencil rather than to trace the outlines direct, and then to measure from the tracing. It was felt that

the use of a tracing may have introduced a further source of error and that it was more accurate to mark on the film directly since the superimposition of tracing paper imposes a

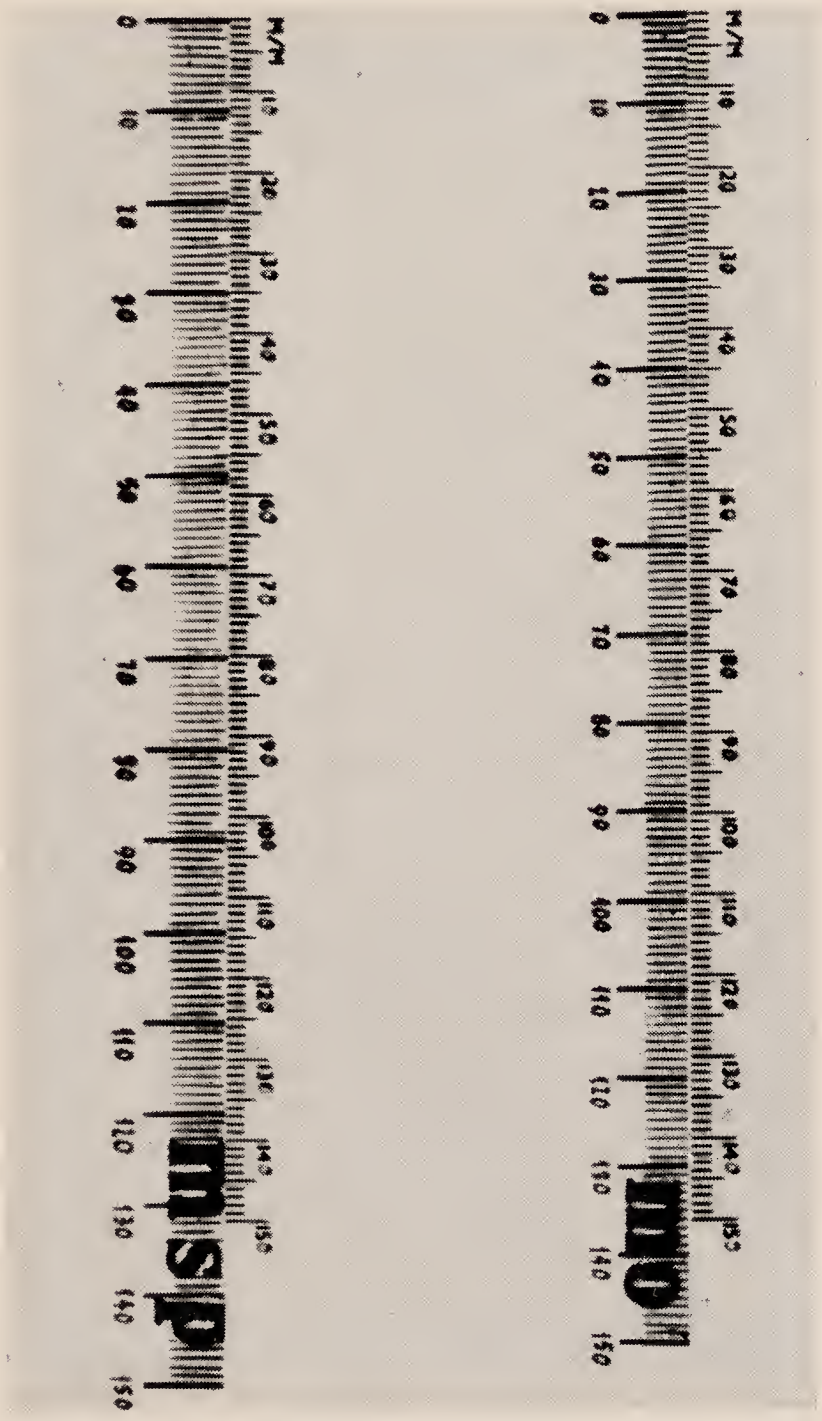

Fig. 5.—Conversion scales to correct the magnification of the film image; msp is for dimensions in the midsagittal plane and mo for those on the left side in the plane of the buccal segments.

certain amount of blurring and can render it difficult to pick out some of the more inaccessible landmarks.

The Measurements Employed.—Thirty-six measurements were made on each lateral skull X-ray in the series, making a total of 3600 in all. Those which seem relevant to the present investigation are as follows (*Fig.* 6).

The Septal Angle (*ANS–S–Ba*).—The measurement is made in association with measurements of cranial base angulation to investigate the relationship between the degree of flexion present in the cranial base as a whole and the projection of the maxilla from it. One arm of the angle is the line sella–ANS which may be taken to represent

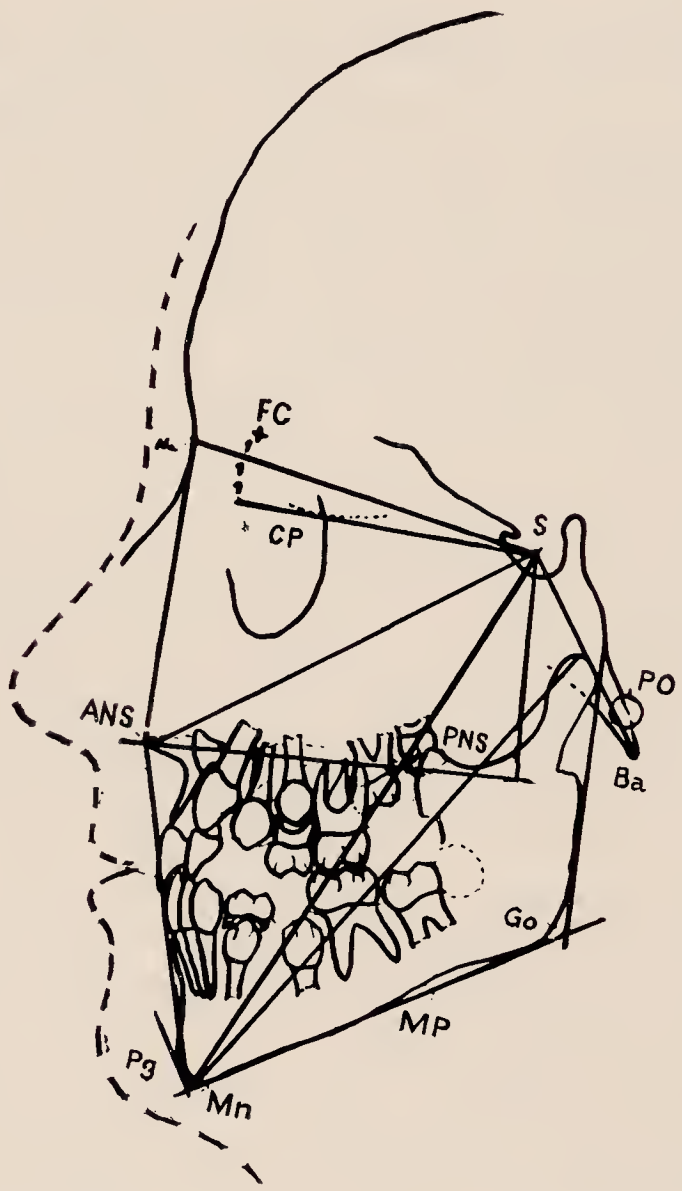

Fig. 6.—The landmarks used in the linear and angular measurements.

the general long axis of growth of the nasal septum, and the septal angle will give some indication of this long axis in relation to the posterior-cranial base which forms the other limb of the septal angle.

Sella to Anterior Nasal Spine (*Sella–ANS*).—In addition to indicating the general axis of growth of the nasal septum this dimension will also be recorded in order to indicate the size of the septum in the line of its axis of growth.

Anterior Nasal Spine to Basion (*Ba–ANS*).—This dimension will show the combined effect of differences in the septal angle and the distance sella–ANS. The measurements in any given subject may be such as to either cancel out their mutual effect on the positioning of the anterior nasal spine or they may be

complementary, that is, a combination of a small septal angle and a short sella–ANS distance will have an additive effect in approximating the anterior nasal spine and the maxilla, to which it is attached, to the basion.

Anterior to Posterior Nasal Spine (*ANS–PNS*).—It was thought that some indication of maxillary depth along the nasal floor would indicate any relationship that may be subsequently found between maxillary depth as depicted in this way and other dimensions affecting the nasal septum.

Upper Anterior Face Height (*Na–ANS*).—The nasion has been chosen as the upper limit for the measurement of upper anterior face height since it has been so frequently used in the past and is a very easily identifiable landmark. It may have been preferable to have used the foramen caecum or some point on the cribriform plate instead, but although these landmarks may be fairly well identified for the purpose of cranial base length or angulation, they did not seem very suitable for vertical facial measurements. In any case it was the measurement of the actual external facial skeletal parts that was desired.

Upper Posterior Face Height (*S–ANS–PNS*).—This dimension was measured to complement the above and to discover if differences in anterior face height were mirrored by that of the posterior.

The Distance of the Posterior Nasal Spine from the Sella (*S–PNS*).—This measurement was intended to be compared with the distance of the anterior nasal spine from the basion as an indication of anteroposterior maxillary positioning.

The Percentage of Upper to Total Face Height.—This was calculated in case there should be any difference between the groups and also in case the resulting figures may be useful for future reference as the percentage has been so frequently calculated.

Total Face Height (*ANS–MP*).—This was measured in order to investigate any difference between the groups which may have unintentionally influenced their selection and may also have some bearing upon other facial measurements undertaken.

Cranial Base Measurements.—Both angulation and length have been taken into consideration and the cranial base has been divided into two parts, anterior and posterior, with the division at the centre of the pituitary fossa. The posterior limit has been fixed at the basion representing the profile of the anterior margin of the foramen magnum in the midline. This landmark can be picked out quite well by following down the inferior aspect of the clivus. It has the advantage over the Bolton point that it is in the midline and more certainly identified. Björk (1947) used articulare to indicate the posterior limit of the cranial base, but stated (1951b) that basion could be distinguished if sufficiently hard X-rays were used. Articulare is defined by Björk (1951a) as the point of intersection of the posterior contours of the ramus with those of the cranial base. However, it would seem to the present writer that measuring from nasion to articulare was only measuring the distance of nasion from the articular process of the mandible and not really a measure of cranial base at all, since it depends upon the intersection of the outline of a structure with the cranial-base profile line in relation to which it is external and independent. Naturally, on this basis, shortening and lengthening of the cranial base as indicated by Na–Art will automatically alter the position of the maxilla in relation to the mandible. The real test of the effect of cranial base length would be if the length from the basion forwards were different in cases of malocclusion. This, of course, depends upon the validity of the assumption by Scott (1948), already mentioned, that the total effect of spheno-occipital synchondrosis growth will be in an upward and forward direction, thus making basion the only stable reference point in the whole cranial and facial regions.

The Bolton point was used by Craig (1951), but it seems a rather indefinite landmark to identify.

The anterior limit of the cranial base was determined in two ways: (1) Nasion; (2) The foramen caecum.

Anatomically the anterior limit of the cranial base should be at the foramen caecum. Ford

(1958) states that the cranial base from sella to foramen caecum exhibits a 'neural' rate of growth, but that the distance from the foramen caecum to the nasion exhibits a skeletal rate. If, therefore, we wish to discover an original deficiency in anterior cranial base length, which may be related to the orientation of the maxilla, it would be found in a deficiency of that part of the cranial base whose size was laid down in cartilage, and where a deficiency, once established, would be distinguishable at any age. The sella–nasion distance includes that part of the anterior cranial base still exhibiting the skeletal growth-rate, and as Ford found that frontal bone thickness increased during the whole of the growing period, it may be that the prolongation of the skeletal growth period could mask an original deficiency in anterior cranial base length from sella to foramen caecum. Scott (1958) states: 'This early stabilization of the ethmoidal region is overlooked in the use of measurements of the anterior cranial base taken from pituitary fossa to nasion as by Brodie (1941), Grossman and Zuckerman (1955).'

Usually the foramen caecum could be located by following the curvature of the cribriform plate anteriorly until a break occurred in the outline as it passed into the internal ridge of the frontal bone. The line used for measurement was drawn as the tangent to the lowest point of the cribriform plate, the length being determined by drawing an arc of a circle using the distance sella–foramen caecum as the radius (*Fig.* 6).

Angular Measurements of the Cranial Base.—The posterior arm of each angle was taken as the line from the basion to the centre of the sella. The anterior arms were marked by joining sella with the lowest point of the cribriform plate and nasion (Ba–S–CP and Ba–S–Na). The site of flexure of the cranial base has been discussed by Scott (1958). Usually, it is taken as the presphenion (sphenoethmoidal suture), but Scott points out that this is unlikely as it would involve a thrusting backwards of the maxilla and palatine bones against the median pterygoid plates in the facial skeleton. Björk (1955) puts the site of rotation at the spheno-occipital synchondrosis. Scott (1958), however, considers another site which persists in man up to birth and in monkeys and lower mammals for a much longer period—that at the synchondrosis between the presphenoid and the postsphenoid elements of the body of the sphenoid bone.

Changes found in the cranial base angle in man after birth using sella–nasion as the anterior limb may be due either to a change in the position of the nasion in relation to the foramen caecum, or, as Björk (1955) suggests, to changes at the spheno-occipital synchondrosis.

Many other measurements were made, principally for the purpose of constructing the mean diagrams. One of these, used to indicate the tilt of the mandibular plane, will be referred to later. This is the angle between the line joining sella to the chin point and the mandibular plane (S–MP).

THE RESULTS

Statistical Criteria.—One purpose of the investigation is to discover the nature of the differences that must undoubtedly exist between the facial types chosen. Although it is recognized that very great individual variation can and does exist and that the measure of one or two angles or linear values only cannot typify a 'class' of face, nevertheless the comparison of mean values can give some indication of general differences if it is done in such a way that individual variation is taken into account. This can be achieved by calculating Student's 't' value, which makes use of the standard deviation in such a way that the greater the variation within a sample the less likely is a difference between means to be significant. In obtaining the differences between the means, the values for the good facial balanees and occlusion have been taken as the controls and the mean values for the corresponding readings on the small middle third face types subtracted from them. In the case of the large middle third types, the value of the control has been subtracted from them. The significance of the differences has been shown by the calculation of the 't' value in

the accepted manner. The 't' value will then give the probability by reading off from tables to be found in statistical texts. With the number of degrees of freedom used ($N+N-2 = 80-2 = 78$) the 5 per cent level of significance of 't' is 2·00. It is generally accepted that the 5 per cent level is sufficiently critical to indicate a significant difference in medical statistics (Geigy, 1956). The level of 't' (2·66) which indicates only a 1 per cent probability of the differences arising by chance has been added in order to help differentiate shades of differences between the 5 per cent and the 1 per cent probability. Similarly, the 10 per cent level of probability was calculated, when 't' is 1·67.

Table I.—Good and Small Middle Third Differences

Measurement	Good	Small	Diff.	't'
Septal Angle ANS–S–Ba	95·8°	93·1°	2·7°	3·2
Sella–ANS	76 mm.	72 mm.	4 mm.	2·8
Na–ANS	47·4 mm.	45·9 mm.	1·5 mm.	1·9
Post. Face Height Sella–ANS–PNS	38·5 mm.	36·6 mm.	1·9 mm.	2·2
ANS–PNS	46·8 mm.	44·5 mm.	2·3 mm.	3·2
Sella–Nasion	63·5 mm.	61·1 mm.	2·4 mm.	2·7
Sella–Ba	40·1 mm.	38·4 mm.	1·7 mm.	1·9
FC–Ba	86·9 mm.	84·8 mm.	2·1 mm.	2·1
Angle Ba–S–Na	134·5°	132·5°	2·3°	1·67
Cribriform Angle Ba–S–C–P	129·9°	128·2°	1·7°	1·6
S–MP	34·1°	31·7°	2·4°	3·1

The Differences found between the Good and Small Middle Thirds (*Table I*).—The diagram was constructed from the means of each of the two groups. Broken lines indicate the controls and solid lines the subjects under examination (*Fig.* 7).

Septal and Facial Measurements.—

1. *The septal angle* (*ANS–S–Ba*): This angle has been measured for reasons already given, and a considerable difference has been found between the controls and the small middle thirds. A 't' value of 3·2 shows the difference to be very significant.

2. *The distance sella to ANS*: Again a significant difference is found in this dimension and 't' is 2·8. Because they are complementary, the effect of these two measurements may be considered together. By examining the superimposed diagrams, it may be seen how both the more acute septal angle and the smaller length of sella–ANS can affect the positioning of the maxilla in relation to the cranial base. This over-simplified cause and effect relationship may be made a little more acceptable later on, when the dynamic rather than the static implications are considered.

Other measurements related to proportions of the middle third may now be considered.

3. *Upper anterior face height* (*Na–ANS*): A small difference only was found in this dimension and the 't' value does not quite reach the 5 per cent level of significance ('t' is 1·9). However, it may be near enough to be worthy of consideration and to indicate, at least, a fairly strong tendency for the upper anterior face height in the small middle thirds to be smaller than that of the controls. Although more difference might have been expected, it can be shown that the more acute septal angle has the effect of increasing the distance between the anterior nasal spine and the nasion.

4. *Posterior face height*: This dimension was measured as the perpendicular from the centre of the sella to the line ANS–PNS. A more significant difference is found, 't' being 2·2. The diagram shows how the reduced septal angle has the effect of tilting the nasal floor so that the posterior nasal spine is brought nearer to the sella.

5. *The length of the nasal floor* (*ANS–PNS*): The nasal floor in the small middle thirds was 2·3 mm. smaller than in the controls, with a 't' value of 3·2. This is highly significant and may be associated with the small sella–ANS dimension.

Cranial Base Measurements.—

1. *Sella–nasion*: Sella–nasion is the more usual measurement made to represent the anterior limb of the cranial base. This is probably because its landmarks are easily identified. Nevertheless, the continuing surface deposition at the nasion must be borne in mind when considering the validity of this point as representing the anterior end of the cranial base. Therefore, although a significantly large difference was found between

the small middle thirds and the controls ('t' is 2·7), the importance of this will be reduced when it is recorded that no difference was found in the truer length of the anterior limb of the cranial base from the sella to the foramen caecum. An explanation for this finding may, however, still be found, connected with the morphology of the subjects under consideration. Possibly the general backward position and growth direction of the middle

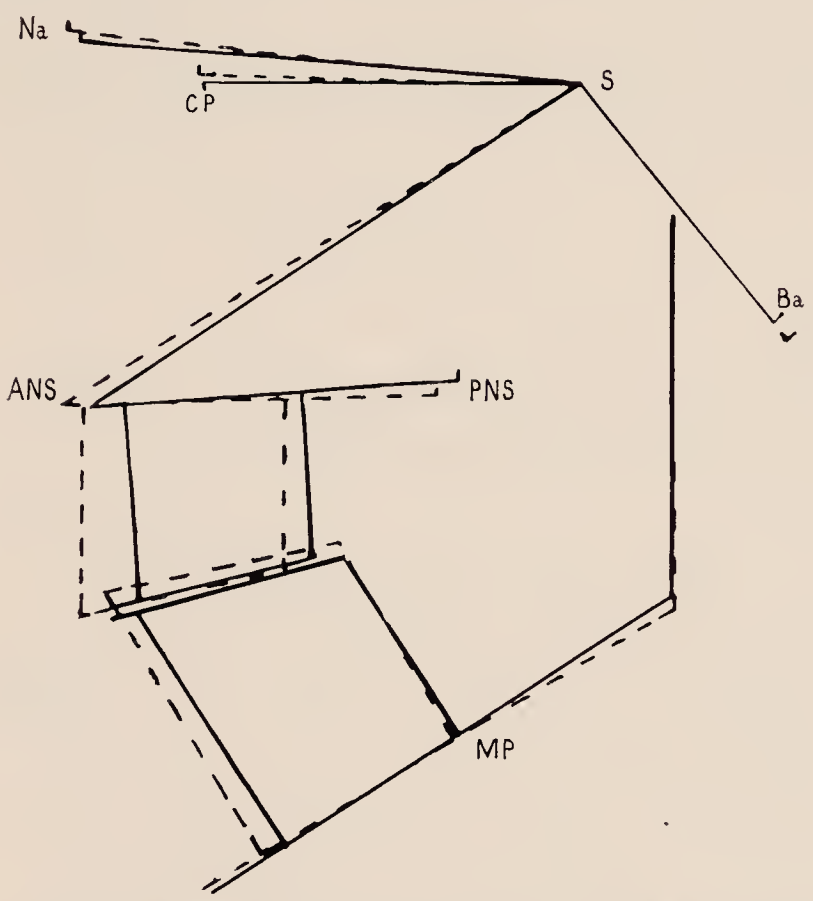

Fig. 7.—Mean diagrams of the small and good middle thirds superimposed on the line Ba–S and registered on the sella. Solid line for small middle thirds and broken line for the good.

third may be reflected in a reduced amount of surface deposition at the nasion.

2. *The posterior cranial base* (*sella–Ba*): The difference found here is again on the borderline of significance, 't' is 1·9. However, when the total cranial base length is examined, that is, the sum of the lengths of the anterior and posterior limbs, then a significant difference results, 't' is 2·1. (FC–Ba, *Table I*).

There now remains the cranial base angulation to consider. Neither of the angles measured shows a difference better than the 10 per cent level so that one can only regard it as a tendency for the cranial base angles to be more acute in the small middle thirds than in the controls (*Table I*). However, that there is some connexion between these angles and that called the septal angle may be gathered from the fact if any one of them, for example, the septal angle, is arranged in descending order of its readings, then the other two angles fall into the same order.

One other measurement that may be noted in passing is one of the reconstruction measurements, S–MP. This indicates indirectly a more obtuse angle of the mandible in the small middle thirds.

Summary of the Differences between the Small Middle Thirds and the Controls and Some Conclusions.—

1. There is some evidence for a greater degree of flexion of the structures associated with the cranial base.

2. There is quite a strong tendency for dimensions in the region of the nasal capsule to be generally smaller.

The Origins of the Differences.—As the degree of cranial base angulation is probably determined during foetal life, some of the factors which may give rise to a retropositioning of the maxilla and middle third could be present at birth and possibly inherited. It could then be put forward that those who are to have a small middle third appearance will have the following features present, or potentially present, at birth. These are:—

a. A more acute angle between the anterior and the posterior limbs of the cranial base, including in this the angle made by the axis of the nasal septum from sella to ANS as used in the calculation of the septal angle.

b. A tendency for the posterior limb of the cranial base to be shorter in length.

c. These features will lead to the future growth at certain centres such as the spheno-occipital synchondrosis and the nasal septum to have less than the usual degree of forward component in their effects.

d. From the reduced size of what may be considered to be the nasal septum axis and also the nasal floor, APS–PNS, it may be possible that the general size of the nasal capsule is smaller, so that the membrane bone of the maxilla which is applied externally to it will give rise to a smaller structure.

Differences between the Large Middle Thirds and the Controls.—The differences found were limited to two measurements from the point of view of significance. They are as follows (*Table II*):—

a. The length of the nasal floor (ANS–PNS) (*Fig.* 8).

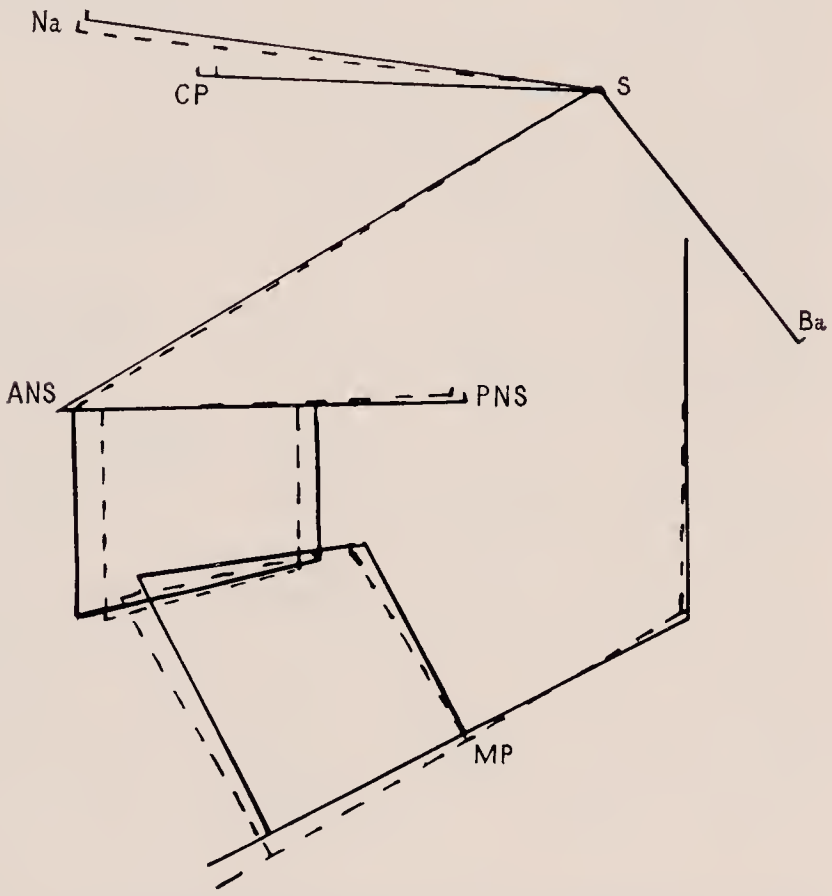

Fig. 8.—Mean diagrams of the large and good middle thirds superimposed on the line Ba–S and registered on the sella. Solid line for the large middle thirds and broken line for the good.

Table II.—Large and Good Middle Third Differences

Measurements	Large	Good	Diff.	't'
ANS–PNS	48·8 mm.	46·8 mm.	2·0 mm.	2·2
Sella–FC	49·2 mm.	46·8 mm.	2·4 mm.	2·7

b. The anterior limb of the cranial base (sella–foramen caecum) (*Fig.* 8).

It may be seen from the diagram that the lengths sella–nasion are almost identical. There is some tendency for the length of sella–ANS to be a little greater, but no significance can be attached to this.

The only explanation present in the measurements to account for the protrusion of the middle face that seems to be present would be to suggest that these subjects possess a somewhat longer maxilla, as evidenced by the dimension ANS–PNS, which is associated with a longer anterior limb of the cranial base.

GENERAL CONCLUSIONS

Many of the differences found are associated with parts that were originally part of, or closely connected with, the cartilage of the chondrocranium. Relationships established at this stage will have an effect upon the direction to be taken by future growth and also upon the size to be attained by some of the component parts of the face. It is possible that the inheritance of facial resemblances between members of a family have their origins in the morphology of the chondrocranium.

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DISCUSSION

Mr. J. H. Hovell, opening the discussion, said that Mr. Knowles had mentioned the effects of condylar hyperplasia and hypoplasia in the production of secondary maxillary deformities. These deformities were due to cartilaginous growth errors and the mandible was changed, not only in size, but also in form. In condylar hypoplasia, there was excessive development of muscular attachments and, in hyperplasia, a bowing of the mandible. In the differences of growth with which they as orthodontists were dealing, the abnormalities were usually only in size. He wondered, therefore, whether a just comparison could really be drawn between them. In a truly dynamic view of growth, one could not take skeletal growth by itself, but had to consider correlation between the skeleton, muscles, and soft tissues. This was particularly shown in pathological growth states where an individual bone grew incorrectly and this growth was then much modified by the muscles.

He had always understood that with a decreased cranial base angle there was an increase in facial prognathism. Mr. Knowles apparently thought the opposite was true.

He felt that Mr. Knowles's method of selecting his cases affected the results to a certain extent. The fact that he had succeeded in getting a large number of cases with retrognathism was creditable to his powers of selection, especially as most of the cases tended to be Class III. One got quite a lot of retrognathic maxillae in Class II cases and of prognathic maxillae in Class III cases. In fact, when he himself had analysed one hundred Class III cases, using not ANS but Down's A point, he had found the mean SNA in Class III was exactly the normal mean for the population. He wondered whether if Mr. Knowles repeated his work using retrognathic maxillae and even more retrognathic mandibles, he would get the same results.

Mr. Knowles said that he agreed that the hyperplastic and hypoplastic mandibles were due to pathological conditions with an abnormal structure and form. It seemed to him that, even so, the maxilla was secondarily affected by the abnormal mandible. They hoped, in Liverpool, to take some young children with unilateral hypoplasia and put bone-grafts into them at regular intervals on the affected side. It was hoped that by doing this perhaps once every eighteen months, the natural process of growth of the maxilla on that side would be stimulated and that the development of the maxilla would be normal. Mr. Hovell mentioned some Class III cases with protrusive maxillae and Class II cases with retrusive maxillae. He had avoided the latter because it might be thought that mandibular growth had affected that of the maxilla. This seemed less likely with the protrusive mandible.

He intended to measure the cranial base angles in cases with mandibular prognathism and when he had sufficient cases to be statistically sound, he would be prepared to comment.

Mr. A. J. Walpole Day said that Mr. Knowles at the beginning of his talk had said that the maxilla grew downwards if there was room for it to grow downwards and, conversely, if room were not made for it to grow downwards, it was restricted and, in illustration of the point, Mr. Knowles had shown a hypoplasia of the condyle and hyperplasia. Towards the end of the talk, Mr. Knowles had said that his conclusion was that the prognathism of the maxilla or retrognathism of the maxilla was due to the angle of growth of the cartilage in the cranial base and did not relate that in any way to the amount of room available. He asked if Mr. Knowles had included the angle of growth of the mandibular cartilage in those views or not.

Mr. Knowles said that he had made many measurements concerning mandibular position and had found no difference in any of the subjects except for a slight one in one particular aspect; in those described as the small middle thirds, there was an indication that the mandibles had more obtuse angles. He interpreted that as a general bending back of the whole facial structures so that the more acute cranial base and septal angles would be associated with the tendency to have a rather more obtuse mandibular angle.

Mr. G. C. Dickson said that in Mr. Knowles's measurements of the cranial base and maxillary structures he had shown a difference between his groups which was statistically significant. Looking at his average diagrams, it was impossible to avoid the feeling that the dental discrepancy was very considerably greater than the cranial base discrepancy. This could presumably be interpreted in two ways; either that the cranial base discrepancy set in motion a chain of events which resulted in a greater occlusal discrepancy or, alternatively, that the cranial base discrepancy did not matter very much and one assumed that the malocclusion had come from other causes. He asked Mr. Knowles to comment on that.

Secondly, he could not help feeling that the two groups of cases, which had been selected *subjectively* and then subjected to *statistical* analysis, were a rather dangerous basis on which to work. To start with, it meant that nobody else could repeat the work because, presumably, they would have a different subjective selection. He was sure Mr. Knowles must have had a good reason for this, but would like to know why he did not pick on some particular measurable angle such as ANB rather than making a subjective selection.

Mr. Knowles said that it might be possible that, as one progressed down from the cranial base, a small discrepancy there could lead to a gradually increasing dental discrepancy, as no doubt Mr. Dickson had found.

As far as selection was concerned, it had given him some concern and he had wondered about using one measurement, but there seemed to be so much individual variation in people as far as a measurement of that sort was concerned that one might well find somebody with what appeared to be a Class II relationship presenting with a bigger angle than a Class III relationship. He was suspicious of ANB and SNA and SNB since he had examined many cases with ideal occlusions and found an angle ANB of anything up to 8°. These angles, in his opinion, depended to a large extent on an alveolar and not a skeletal base point.

Mr. D. A. Dixon said that it had been shown that Mr. Knowles had a keen clinical eye, and he thought that the changes in cranial base relationship shown were related in some degree to the differences in facial prognathism in the two groups selected. Mr. Knowles had pointed out a very important subject which was neglected; the differences in the vertical form of the face. He himself had recently been using a vertical classification as a trial.

He asked Mr. Knowles to commend any similar form of clinical analysis which he himself used in differentiating clinical types, which was one of the most important fields for an orthodontist.

Mr. Knowles said that there was some difference in vertical proportions in the small middle thirds which was not statistically significant; there was only a tendency that way. Not having found as much vertical difference as he would have expected, he could not really tell of any way in which those measurements could be applied to a vertical classification, although he agreed that such considerations were necessary in working out prognosis.

Mr. S. Haynes asked Mr. Knowles to give the range of variation found in the control cases for the cranial base angle and to compare it with the range found in the Class II and Class III cases.

Mr. Knowles said, taking the line sella–nasion as the anterior limb, the smallest reading was 122° for the small middle third and the biggest 137°. The same angle on the controls was 127° for the smallest and 152° for the largest. For large middle thirds, the smallest was 123° and the largest 145°. There was quite an extensive range. The bigger the range the more it affected the standard deviation.

CEPHALOMETRIC ANALYSIS OF 100 ANGLE CLASS II, DIVISION 1 MALOCCLUSIONS WITH SPECIAL REFERENCE TO THE CRANIAL BASE

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THE Angle Class II, division 1 malocclusion has possibly aroused more interest and caused more disagreement among orthodontists than any other irregularity of the teeth. Fisk, Culbert, Grainger, Hemrend, and Moyers (1953) have commented on the mass of dogma, sacred tradition, and myth which surrounds the subject and, indeed, this has obscured the fact that surprisingly little is known about many aspects of this malocclusion. The factors which have been investigated have been summarized by three groups of authors, Fisk and others (1953), McKeag and Scott (1956), and Krogman and Sassouni (1957), the latter being concerned principally with cephalometric studies. All three groups of authors emphasize in their conclusions that wide variations of craniofacial patterns are found within the Angle Cl. II, div. 1 grouping. Furthermore, it is generally agreed that it is a combination of several unfavourable morphological factors which causes the malocclusion rather than any one specific feature (Björk, 1947; Elasser and Wylie, 1948).

This combination of factors must be kept in mind when assessing the results of a cross-sectional study expressed in terms of mean values. Nevertheless, the cross-sectional type of investigation may assist in reaching a better understanding of the nature of the malocclusion and of the effect the various factors may have on the malocclusion.

One area of the craniofacial complex which has been the subject of increasing attention in recent years is the cranial base. Björk (1947) demonstrated the possible influence which changes in the size and shape of the cranial base might have on facial prognathism, and in later papers (1953, 1955) he considered changes occurring during growth and the effect this could have on prognathism. Scott (1958) has also investigated this area with particular regard to growth changes, but he commented that much work was still required on the precise relationship which exists between variations in size and angulation of the cranial base and certain forms of dentofacial deformity. The need for more information was also stressed by Krogman and Sassouni (1957), who also comment on the relative newness of the problem in the orthodontic field. The effects of cranial base factors on the position of the maxilla was the subject of a recent paper by Knowles (1963).

Much of the interest shown by orthodontists regarding the cranial base has arisen from the various attempts to find a relatively stable portion of the cranial base suitable for a reference point in cephalometric analysis. There is now a better appreciation of the variability during growth of the structures involved in the area and conclusions drawn from any analysis have become more guarded. One objective of this study was to find out if the mean values for the linear and angular measurements of the main features of the cranial base in individuals with Angle Cl. II, div. 1 malocclusions show any significant differences when compared with those of a control group. It is realized, however, that if any significant variations from the normal group were apparent these differences would not be present in each and every individual of the Angle Cl. II, div. 1 groups and only an overall trend would be demonstrated.

A secondary objective was to investigate a clinical concept which has long been employed in the diagnosis of the Angle Cl. II, div. 1 malocclusion. This technique owes its origin to Case (1921) and has been described in various articles (Higley, 1948; Dockrell, 1951; Logan, 1952; Henry, 1957). It consists essentially of dividing the types of facial pattern in which an Angle Cl. II, div. 1 malocclusion

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may occur into the following: (1) Where the whole maxilla is forward relative to the skull (maxillary protrusion); (2) where the maxilla is in normal relationship to the skull but the maxillary teeth and alvcolus are forward (maxillary alveolar protrusion); (3) whcre the whole mandiblc is too far distal (mandibular retrusion); (4) where the mandible is in normal relationship to the skull but the mandibular incisors are lingually placed (mandibular alveolar retrusion). These types may be present separately or in combination in any one individual. A cephalometric radiographic investigation is one way of testing the validity of this concept, since, if the classification is to be applied clinically, it is important to know just how accurate its assumptions are. It is of particular importance in this instance sincc the treatment plan devised for a particular individual may well be based on the classification system described above.

Table I.—Age Distribution of Male and Female Angle Cl. II, Div. 1 Groups and Control Groups

Age in Years	Males		Females	
	No. of Angle Cl. II, Div. 1	*No. of Controls*	*No. of Angle Cl. II, Div. 1*	*No. of Controls*
6	0	2	0	1
7	1	9	2	1
8	8	4	3	12
9	12	6	13	8
10	12	3	12	15
11	10	16	12	10
12	3	3	8	6
13	2	2	—	1
14	2	2	—	—
Total	50	47	50	54

The idea for the study of the cranial base was suggested by Dr. G. B. Hopkin, Edinburgh University Orthodontic Department, who had previously made a long-term ccphalometric radiographic survey of a large group of Anglc Cl. III malocclusion patients (Hopkin, 1961). When his Angle Cl. III groups were compared with control groups of individuals with normal occlusion or Angle Cl. I malocclusions the cranial base seemed to play a major part in the genesis of the Angle Cl. III malocclusion, and hence it seemed of value to extend the investigation to include the Angle Cl. II, div. 1 malocclusion. In addition to the cranial base factors, certain other measurements which had proved of interest in the Angle Cl. III study were also included. This report is confined to an assessment of the differences bctween the Angle Cl. II, div. 1 groups studied and their controls. It is intended to publish a joint report with Dr. Hopkin on thc combined Angle Cl. II, div. 1 and the Angle Cl. III material.

MATERIAL

Lateral skull radiographs of 100 patients who had been diagnosed clinically as having an Angle Cl. II, div. 1 malocclusion were selected at random from the files of the orthodontic department.

The Angle classification was made on the basis of the molar or corrected molar occlusion and the canine and incisor relationships. There is occasionally doubt as to the divisional classification of the Angle Cl. II grouping (Walther, 1960a), therefore only individuals whose upper central incisors were proclined, or were vertical with an increased overjet, have been included. All the subjects were in the 'mixed dentition' phase, i.e., after the first permanent molars and central incisors werc in occlusion, but before the second permanent molars were in occlusion. None of the patients had received treatment prior to the taking of the radiograph. The sample was composed of 50 boys and 50 girls with an age range of 7–14 years.

The control groups were the male and female mixed dentition neutrocclusion samples used by Hopkin in his Cl. III study. Some of these controls had normal, or near normal, occlusions, but some Angle Cl. I malocclusion patients had to be included. The sample was composed of 47 boys and 54 girls with a joint age range of 6–14 years. *Table I* shows the distribution of the groups, and it may be observed that the greater part of both the Angle Cl. II, div. 1 and control samples fell within the range 8–12 years.

The use of a control group whose radiographs had been traced and measured by another investigator has the obvious advantage of

saving a considerable amount of labour and time, but there is always the possibility of differences due to variations in technique. To reduce this hazard, care was taken to standardize the tracing method and to clarify any points which might lead to confusion.

As a matter of interest, out of 100 individuals classified by the Angle method of occlusal relationships as Cl. II, div. 1, 76 showed a difference in the relationship of maxilla to mandible as measured by the angles SNA and SNB of more than +4°, i.e., Skeletal II dental base (Walther, 1960b), 18 had a difference of between + 2° and + 4° (Skeletal I), and 6 had a difference of less than +2° (Skeletal III). The large number of subjects with a Skeletal II dental base relationship emphasizes how important the skeletal factors are in the majority of Angle Cl. II, div. 1 malocclusions, as Björk (1947) has already pointed out. The presence of the Skeletal III group illustrates the variations which may arise between the Angle classification and the Skeletal classification.

METHOD

The radiographs were taken with the patient positioned in a Shandon cephalostat. The distance from the X-ray tube to the centre of the cephalostat (median sagittal plane of the patient) was 64·5 in. and from the centre of the cephalostat to the film it was 7·5 in., i.e., tube–film distance was 72 in.

Tracings of the films were made using an 8H pencil and the planes and angles to be measured were construeted on the tracings. The ten linear measurements were made with fine callipers having a vernier seale to $\frac{1}{10}$ mm., and the seven angular measurements with a circular protractor of 4-in. radius giving clear readings of 0·5°. *Fig.* 1 illustrates the points used; in all cases the definition of points and planes is that given in Krogman and Sassouni (1957) as that most commonly used. The linear measurements employed were nasion–articulare, nasion–sella, sella–articulare, articulare–gonion, gonion–gnathion, articulare–gnathion, anterior nasal spine–posterior nasal spine, nasion–anterior nasal spine, anterior nasal spine–gnathion, and nasion–anterior nasal spine +anterior nasal spine–gnathion. The angular measurements were nasion–sella–articulare, articulare–gonion–gnathion, sella–nasion–pt.A, sella–nasion–prosthion, sella–nasion–pt.B, sella–nasion–infradentale, and sella–nasion–pogonion. The most controversial point used was probably articulare, as both Hopkin (1961)

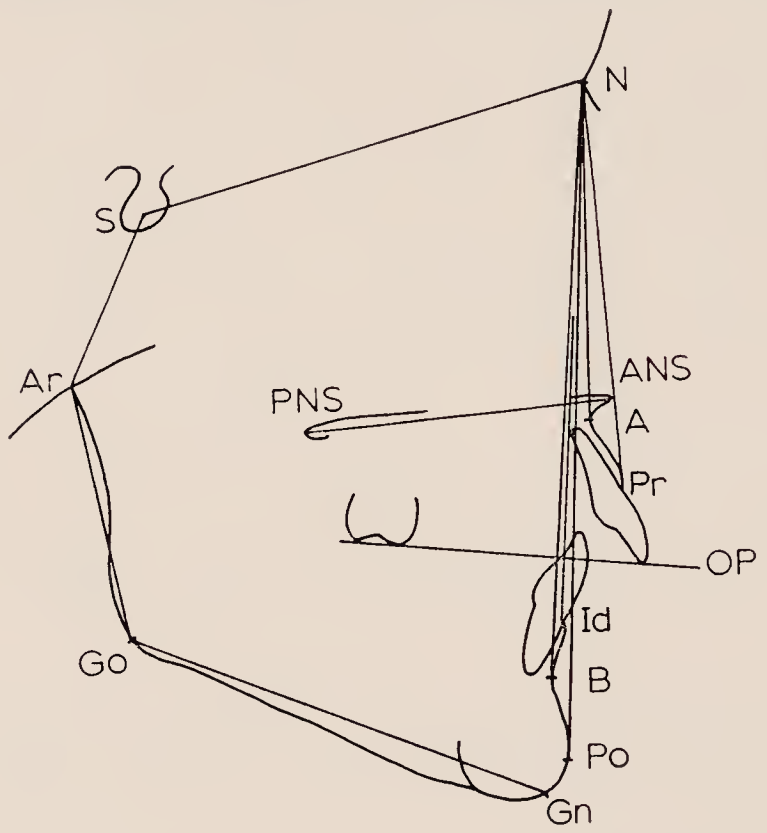

Fig. 1.—Points and planes used in the analysis.

and Knowles (1963) have stressed that it is not the anatomical end-point of the posterior arm of the cranial base. It was, however, used with the control study owing to the difficulty in identifying basion with the radiographic technique then in use and it has therefore been employed in the present study for comparative purposes. All measurements are given as the Mean±Standard Error of the Mean and the Standard Deviation. Comparison of the mean values of the measurements was made using the '*t*' test (Snedecor, 1956). The results are given in *Tables II–V* and '*t*' values are included where these are 2·0 or above, i.e., significant at the 5 per cent level or less.

RESULTS

Cranial Base Measurements (*Table II; Fig.* 2).—

Overall Cranial Base Length (*N–Ar*).—This measurement was greater in both the Angle Cl. II, div. 1 groups compared to their respective control groups ($t = 4{\cdot}05$ males; $t = 5{\cdot}53$ females).

Cranial Base Angle (*N–S–Ar*).—The mean value for this measurement was greater in both the Angle Cl. II, div. 1 groups than in their corresponding control groups ($t = 2{\cdot}77$ males; $t = 4{\cdot}78$ females). This increase in the cranial base angle in the Angle Cl. II, div. 1 groups was one of the most striking differences from the controls.

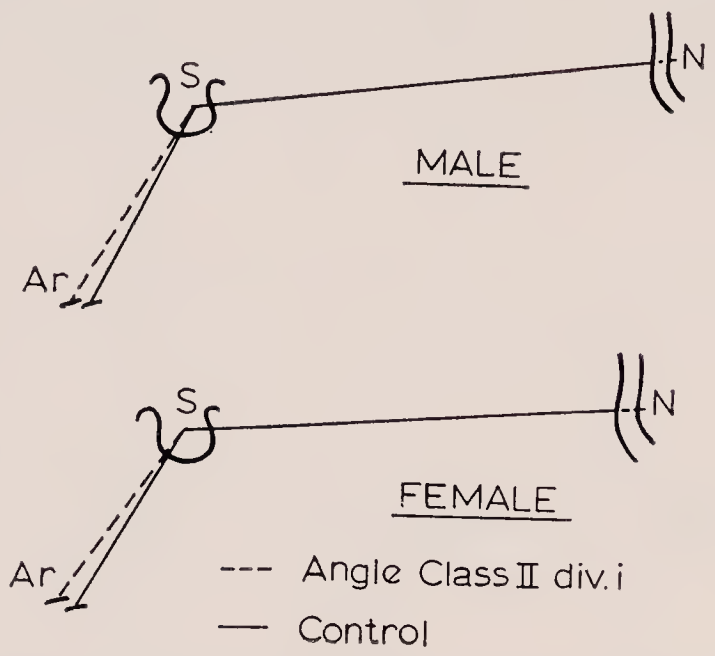

Fig. 2.—Cranial base mean values for Angle Cl. II, div. 1 groups and control groups.

Anterior Cranial Base Length (*N–S*).—This was also greater in the Angle Cl. II, div. 1 groups compared to their control groups ($t = 3{\cdot}42$ males; $t = 3{\cdot}93$ females).

Posterior Cranial Base Length (*S–Ar*).—Both the male and female Angle Cl. II, div. 1 groups gave larger mean values than their control groups, but this increase was significant only for the males ($t = 2{\cdot}16$). This measurement therefore did not show such a difference between the Angle Cl. II, div. 1 groups and their controls as did the other measurements of the cranial base area.

Sex Differences in the Cranial Base.—All the mean linear measurements for the male Angle Cl. II, div. 1 group and male control group were larger than those for the corresponding female groups. This increase in male dimensions has been noted in many other studies, including those of Young, Johnson, Smyth, and Still (1937) and Elasser and Wylie (1948).

The overall cranial base length in the female malocclusion group showed a greater increase over its control than did that of the male malocclusion group over its control One of the factors involved in producing this difference between the sexes would seem to be the greater increase in the cranial base angle in the female Angle Cl. II, div. 1 group. A direct comparison of the angle between the two malocclusion groups showed that the difference between the sexes was significant ($t = 2{\cdot}01$). This was in contrast to a comparison of the male and female control groups in whom the angle was almost identical in size.

The anterior cranial base showed almost the same increase in length in both male and

Table II.—Cranial Base Measurements of Male and Female Angle Cl. II, Div. 1 Groups and Control Groups

Measurement	Males					Females				
	Angle Cl. II, Div. 1		*Controls*			*Angle Cl. II, Div.* 1		*Controls*		
	Mean±S.E. of the Mean	S.D.	Mean±S.E. of the Mean	S.D.	'*t*' Value	Mean±S.E. of the Mean	S.D.	Mean±S.E. of the Mean	S.D.	'*t*' Value
Overall cranial base length (N–Ar)	98·68±0·58	4·05	95·05±0·73	4·77	4·05	96·47±0·65	4·53	91·71±0·56	4·13	5·53
Cranial base angle (N–S–Ar)	126·93±0·70	4·87	124·22±0·69	4·23	2·77	128·89±0·64	4·49	124·30±0·71	5·32	4·78
Ant. cranial base (N–S)	73·43±0·35	2·48	71·48±0·45	3·07	3·42	71·47±0·43	3·01	69·23±0·37	2·76	3·93
Post. cranial base (S–Ar)	35·20±0·40	2·82	33·84±0·48	3·32	2·16	33·87±0·45	3·13	32·97±0·41	3·57	—

female malocclusion groups compared to their controls. There was, therefore, no sex difference in the increase of this measurement.

The posterior cranial base length, besides having a proportionally smaller increase in the malocclusion groups compared with controls, also showed only a slight sex difference between the two malocclusion groups. The posterior cranial base length did not, therefore, appear to be as important a factor in the causation of an Angle Cl. II, div. 1 malocclusion as were the other dimensions of the cranial base.

To summarize the findings with regard to the cranial base, the cranial base angle and both the anterior and posterior cranial base lengths were increased in the Angle Cl. II, div. 1 groups compared with the controls. The cranial base angle in the Cl. II, div. 1 groups showed a sex difference, having a greater increase in the females, while there was no sex difference apparent in the anterior cranial base. The posterior cranial base length was just significantly greater in the male malocclusion group, but the female malocclusion group also showed a slight increase.

The effect of the cranial base differences in the Angle Cl. II, div. 1 groups would be to carry the maxilla farther forwards owing to anterior cranial base increase in length and to move the articular fossa, and with it the mandible, more distally owing to increase in the cranial base angle. Hence the change in the mean values in the Cl. II, div. 1 groups compared with controls has an effect on the relationship of the maxilla and mandible to each other.

Mandibular Measurements (*Table III*).—None of the mandibular measurements made, i.e., overall mandibular length (Ar–Gn), mandibular (gonial) angle (Ar–Go–Gn), vertical ramus (Ar–Go), or horizontal ramus (Go–Gn), showed significant differences between the Angle Cl. II, div. 1 groups and the controls, though the trend of the male Cl. II, div. 1 measurements, all of which were smaller than the measurements for the controls, suggested a smaller mandible in the male Cl. II, div. 1 group compared with controls.

Table III.—Mandibular Measurements of Male and Female Angle Cl. II, Div. 1 Groups and Control Groups

Measurement	Males					Females				
	Angle Cl. II, Div. 1		*Controls*			*Angle Cl. II, Div.* 1		*Controls*		
	Mean±S.E. of the Mean	S.D.	Mean±S.E. of the Mean	S.D.	'*t*' Value	Mean±S.E. of the Mean	S.D.	Mean±S.E. of the Mean	S.D.	'*t*' Value
Overall mand. length (Ar–Gn)	102·96±0·69	4·82	104·97±0·98	6·60	—	103·22±0·58	4·08	101·92±0·73	5·42	—
Mand. (gonial) angle (Ar–Go–Gn)	128·76±0·71	5·00	129·45±0·75	5·09	—	128·90±0·54	3·76	129·51±0·67	4·95	—
Vertical ramus (Ar–Go)	42·69±0·59	4·12	43·57±0·47	3·18	—	42·95±0·44	3·09	42·36±0·55	4·06	—
Horizontal ramus (Go–Gn)	71·05±0·51	3·56	71·77±0·85	5·78	—	70·91±0·54	3·76	70·00±0·61	4·54	—

Sex Differences in Mandibular Measurements.—The male control group measurements were greater than the corresponding measurements in the female controls. This increase in male linear dimensions has already been commented on. This was not the case, however, when the male Cl. II, div. 1 group was compared with the female Cl. II, div. 1 group. The female Cl. II, div. 1 linear dimensions were almost identical with the male Cl. II, div. 1 group.

A similar lack of significant difference in the Cl. II, div. 1 groups is seen in the linear measurements of the maxilla, though it is not so obvious as in the mandible.

Maxillary Length (ANS–PNS) (*Table IV*).—This was significantly greater in the female Angle Cl. II, div. 1 group compared with the female control group ($t = 2{\cdot}06$). The mean length in the Cl. II, div. 1 groups only, a finding similar to those on the mandible.

Facial Height (*Table IV*).—

Total Facial Height (*N–ANS–Gn*).—This was definitely greater in the Angle Cl. II, div. 1 groups than in their corresponding control groups ($t = 2{\cdot}64$ males; $t = 4{\cdot}06$ females). When the two components were considered separately

Table IV.—Maxillary Length and Facial Height in the Male and Female Angle Cl. II, Div. 1 Groups and the Control Groups

Measurement	Males					Females				
	Angle Cl. II, Div. 1		*Controls*			*Angle Cl. II, Div. 1*		*Controls*		
	Mean ± S.E. of the Mean	S.D.	Mean ± S.E. of the Mean	S.D.	't' Value	Mean ± S.E. of the Mean	S.D.	Mean ± S.E. of the Mean	S.D.	't' Value
Maxillary length (ANS–PNS)	52·27 ± 0·39	2·70	52·65 ± 0·42	2·85	—	51·78 ± 0·35	2·45	50·71 ± 0·38	2·80	2·06
Total facial height (N–ANS–Gn)	119·78 ± 0·91	6·39	116·30 ± 0·96	6·54	2·64	118·39 ± 0·76	5·31	113·92 ± 0·80	5·91	4·06
Upper facial height (N–ANS)	53·63 ± 0·43	3·01	52·09 ± 0·58	3·94	2·14	52·91 ± 0·45	3·16	51·02 ± 0·39	2·90	3·15
Lower facial height (ANS–Gn)	66·15 ± 0·70	4·91	64·02 ± 0·69	4·68	2·17	65·59 ± 0·59	4·12	62·71 ± 0·65	4·84	3·27

Table V.—Angular Measurements based on the S–N Line of Lower Facial Prognathism in the Angle Cl. II, Div. 1 Groups and Control Groups

Measurement	Males					Females				
	Angle Cl. II, Div. 1		*Controls*			*Angle Cl. II, Div. 1*		*Controls*		
	Mean ± S.E. of the Mean	S.D.	Mean ± S.E. of the Mean	S.D.	't' Value	Mean ± S.E. of the Mean	S.D.	Mean ± S.E. of the Mean	S.D.	't' Value
∠SNA	77·84 ± 0·54	3·75	79·74 ± 0·49	3·34	2·60	77·78 ± 0·60	4·18	80·81 ± 0·89	6·57	2·83
∠SNPr	80·23 ± 0·53	3·74	81·10 ± 0·50	3·42	—	80·59 ± 0·65	4·55	80·87 ± 0·48	3·51	—
∠SNB	72·00 ± 0·46	3·22	76·58 ± 0·46	3·12	7·05	72·50 ± 0·52	3·61	76·69 ± 0·52	3·87	5·66
∠SNId	73·09 ± 0·48	3·39	78·96 ± 0·55	3·75	8·04	73·69 ± 0·56	3·91	78·36 ± 0·73	5·41	5·08
∠SNPo	73·52 ± 0·46	3·24	78·32 ± 0·54	3·70	6·76	73·91 ± 0·50	3·51	77·67 ± 0·56	4·17	5·01

value for the male Angle Cl. II, div. 1 group was almost identical with that of the male control group. There was no significant difference in maxillary length between the male and female Angle Cl. II, div. 1 groups, while the male control group gave a significantly greater measurement than the female controls. Thus there is no sex difference in maxillary

it was apparent that this increase had occurred in both upper and lower facial measurements.

Upper Facial Height (*N–ANS*).—This was greater in both Angle Cl. II, div. 1 groups compared with their controls ($t = 2{\cdot}14$ males; $t = 3{\cdot}15$ females).

Lower Facial Height (*ANS–Gn*).—This was similar to upper facial height in that the

increases in the Angle Cl. II, div. 1 groups gave 't' values ($t = 2{\cdot}17$ males; $t = 3{\cdot}27$ females) similar to those for the upper face.

Sex Differences in Facial Height.—There was a sex difference in facial height since the female Cl. II, div. 1 group showed a proportionally greater increase than the males. It is considered that this represented a greater lengthening of the face rather than a greater degree of convexity of profile in the females. The basis for this conclusion is the consideration of the angles measuring facial prognathism which are reported next in the results.

Facial Prognathism (*Table V*).—One of the most popular methods of assessing dental base relationship is the ∠SNA–∠SNB difference. This difference, however, is affected by changes in the length of S–N. *Fig.* 3 illustrates the effect of an increase in S–N of 2 mm., which is approximately the amount by which the Angle Cl. II, div. 1 mean values are greater than the S–N distance in the controls. When the angle AN_1B is 5° the angle AN_2B is less than 3°. In practice of course the relative positions of points A and B would not remain constant, but the diagram does illustrate the type of problem inherent in comparing measurements of cephalometric radiographs. Care must be taken, therefore, not to read too much into a comparison of angles in the Cl. II, div. 1 groups and controls when these angles are based on S–N. It was possible to compare the male and female Angle Cl. II, div. 1 groups with each other and when this was done it was apparent that they closely resembled each other in measurements of prognathism. Similarly, the male and female control groups resembled each other. The results given in *Table V* are with the sexes separated, but in the discussion Cl. II, div. 1 groups are considered together and the control groups together.

The angles considered were those recording maxillary basal prognathism (∠SNA), maxillary alveolar prognathism (∠SNPr), mandibular basal prognathism (∠SNB), mandibular alveolar prognathism (∠SNId), and the chin point (∠SNPo).

Maxillary Basal and Alveolar Prognathism (∠SNA and ∠SNPr).—Consideration of the factors involved would suggest that in the control groups a slight increase in the angle measuring alveolar prognathism (∠SNPr) over that measuring basal prognathism (∠SNA) might be expected. In the female controls the increase was 0·06° and in the males 1·36°. When the Cl. II, div. 1 groups were considered the increases in ∠SNPr over ∠SNA were more

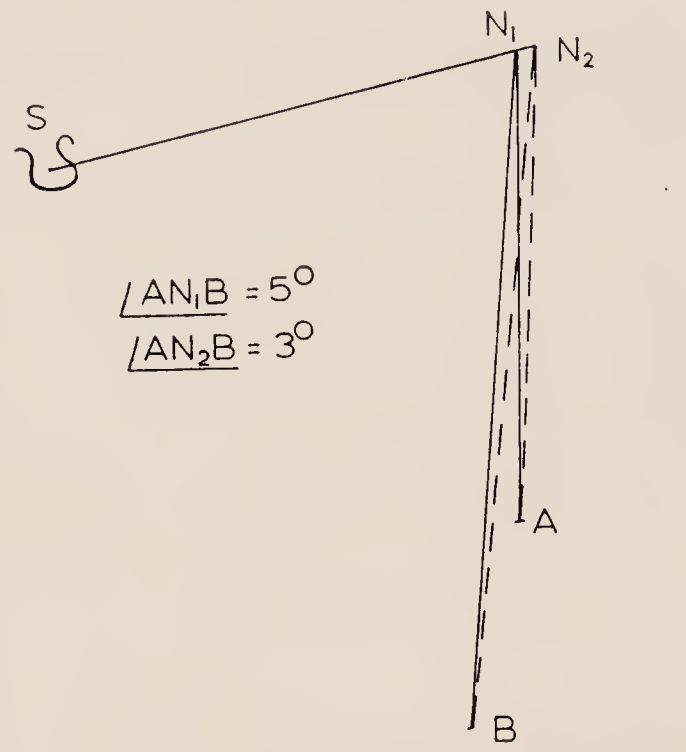

Fig. 3.—Effect of a 2-mm. increase in S–N length.

definite (2·81° for the females and 2·39° for the males). This again is not unexpected in view of the fact that many of the Cl. II, div. 1 group had proclined upper incisors. What was surprising was that of the 100 individuals with Cl. II, div. 1 malocclusions 60 per cent gave an increase of ∠SNPr over ∠SNA of only 2–3° while only 15 per cent gave an increase of 4° and 13 per cent an increase of 5–7°, i.e., only 28 per cent gave differences of 4° or above. It may be concluded, therefore, that in Angle Cl. II, div. 1 malocclusion the majority of individuals do not show a wide discrepancy between maxillary basal prognathism and alveolar prognathism.

Mandibular Basal Prognathism (∠SNB) and Alveolar Prognathism (∠SNId).—The male and female control groups both showed an increase in the angle measuring alveolar prognathism (∠SNId) over the angle for basal prognathism (∠SNB). The differences were 1·67° for the females and 2·36° for the males. When the Angle Cl. II, div. 1 groups were considered the increase of ∠SNId over ∠SNB was 1·19° for the females and 1·09° for the males,

i.e., the variation between mandibular alveolar prognathism and mandibular basal prognathism in the Cl. II, div. 1 groups seemed to be less than the variation in the controls. Mean values may be misleading, but detailed consideration of the Cl. II, div. 1 individuals showed that 91 per cent gave an increase of ∠SNId over ∠SNB of 0°–2°, i.e., the great majority showed a very close relationship of alveolar prognathism to basal prognathism in the mandible.

Chin Point (∠SNPo).—Having established that alveolar and basal prognathism in the mandible were closely linked, the results concerning the chin point (∠SNPo) were of particular interest in view of the clinical impression that individuals with mandibular alveolar retrusion were not uncommon. In this clinical entity the teeth and alveolus would be set well back on the jaw, therefore ∠SNPo would give a considerably larger value than ∠SNB. It was surprising, therefore, to find that 80 per cent of the postnormal individuals had an increase of 0°–2° only when ∠SNPo was compared to ∠SNB. Of the remainder, 17 per cent had a 3° increase. In other words, mandibular basal prognathism and the chin point are closely linked.

To summarize the findings regarding facial prognathism, there was no sex difference in profile of the malocclusion group. Alveolar prognathism showed only a mild degree of protrusion over basal prognathism in the maxilla as regards the majority of the Cl. II, div. 1 sample, while mandibular alveolar prognathism is very similar to mandibular basal prognathism in the great majority of individuals in the Cl. II, div. 1 group. The chin point did not show a wide variation compared with mandibular basal prognathism, but in almost all instances it was only 3°, or less, anterior to point B.

DISCUSSION

The results have suggested that the mean values for the Angle Cl. II, div. 1 groups differ from those of the controls with regard to several different areas of the craniofacial complex. In discussing these variations it is again recognized that they represent a trend and no one individual actually shows all the variations observed in the Angle Cl. II, div. 1 groups.

Comparisons of the findings in this study with those of other workers are not always practicable since the method of study may be different (e.g., the technique employed by Muzj, Maj, and Luzj, 1955) or the age-groups may vary widely, introducing additional problems. Where possible, however, an attempt has been made to consider comparable studies, e.g., Björk (1947) and Marcondes (1956).

Young, Johnson, Smyth, and Still (1937) made a large-scale study of postnormal occlusion nearly thirty years ago, and it remains one of the largest contributions this country has made in the field of aetiology of malocclusion. Unfortunately, a critical study of the anthropometric techniques employed, together with the considerable variation possible in the estimation of soft-tissue features, suggests that some of the conclusions drawn from the results of their investigation are open to question. An example of a false conclusion is the assumption by Young and others that the distance tragus to upper incisor gum margin represents a measure of maxillary prognathism. In fact, it does not, since it does not take account of variation in the length of the cranial base. A longer cranial base would carry the maxilla forwards without necessarily increasing maxillary prognathism. Other assumptions have been made which also must be questioned, and accordingly some of Young and others' findings are not considered as valid.

Cranial Base.—Several earlier writers suggested that the cranial base could play a part in the causation of malocclusion (Hellman, 1931, 1940; Brodie, 1940). Björk selected a small group (32) of 12-year-old boys with extreme increase in overjet and this group, with reservations, may be considered as an Angle Cl. II, div. 1 sample. He found an increase in the cranial base angle and elongation of the cranial base length in the extreme overjet group compared with the main sample. Marcondes (1956) also found an increase in cranial base length and a greater cranial base angle, though he employed basion rather than articulare and did not appear to consider the sexes separately.

It would seem, therefore, that the evidence of this study confirms that of comparable investigations in showing that the cranial base angle is significantly greater and the anterior and, to a lesser extent, the posterior cranial base length is increased in Angle Cl. II, div. 1 malocclusion, the result being a significant increase in overall cranial base length. This study suggests that there is a sex difference in the Angle Cl. II, div. 1 groups as the cranial base angle shows a significantly greater increase in females than in males.

Mandible.—The results regarding the mandible are not easily assessed. The overall mandibular length in the male Angle Cl. II, div. 1 group, while not significantly different from that of the male controls, was less than that of the female Angle Cl. II, div. 1 groups, in contrast to almost all the other male linear measurements which were significantly greater than the female measurements.

The evidence presented by the majority of other workers regarding mandibular size in Cl. II, div. 1 malocclusion is that there is a reduction in size compared with controls. There are many reports concerning the length of the horizontal ramus of the mandible, with the majority finding a slight reduction in length compared with the various control groups, e.g., Hellman (1931) on a sample containing males and females, Björk (1947) boys only being studied, Elasser and Wylie (1948) on males and females, with the girls only showing a decrease, Higley and Nelson (1948) on males and females, Marcondes (1956) on males and females, and Henry (1957) also on males and females.

As regards the vertical ramus this has had much less study, with three authors finding a reduction in size (Drelich, 1948; Renfroe, 1948; Marcondes, 1956) and one (Craig, 1951) finding no difference.

The results of this investigation were that in the female Angle Cl. II, div. 1 groups the mandible showed no significant difference in length from the female controls, while there was a suggestion that the mandible in the male Angle Cl. II, div. 1 group was reduced in both vertical and horizontal measurements compared with the male controls.

The mandible is of particular interest in a study involving children. Björk contrasted 12-year-old boys with adult males, and showed that the lower portion of the face had, on average, still to achieve 15 per cent of its final height, and that of the various components of this region the vertical ramus had approximately 26 per cent of its final height still to be achieved. In other words, the mandible, and particularly the vertical ramus, in a 12-year-old boy has the greatest amount of growth of all the potential facial components. Nanda (1955), in a longitudinal study of a small sample (10 males and 5 females), demonstrated that growth in this component between 10 and 17 years is not so striking in girls as in boys.

Tanner (1961) has emphasized that the sex differences in the lower facial proportions are much more striking after puberty and that the muscle dimensions also increase more markedly in males during the prepubertal growth spurt.

It is suggested that some of the conflicting evidence in the numerous reports concerning size of the mandible in individuals with Cl. II, div. 1 malocclusion may be due to failure to recognize variation caused by age or sex differences. It is important to realize that many of the older children in the present study, particularly girls, will have begun to show the prepubertal growth spurt described by Tanner (1961). This growth spurt, as has already been pointed out, will affect mandibular growth to a greater extent than any other facial dimension, especially in males, and the male control group in the study showed significantly greater dimensions of the mandible compared with the female control group. The male Cl. II, div. 1 group, however, did not show greater dimensions of the mandible compared to the female Cl. II, div. 1 group. This could be due to one of two possibilities. First, a sample at any given age of males with Cl. II, div. 1 malocclusion may show a lack of increased mandibular dimensions compared to an equivalent female group. If this is so, then the reduced size of the mandible as a factor in Cl. II, div. 1 occlusion may be of importance in males only. Secondly, boys with an Angle Cl. II, div. 1 malocclusion may

have a later onset of the prepubertal growth spurt than boys with more normal occlusions. This concept is at least worthy of further consideration when it is remembered that the Cl. II, div. 1 malocclusion tends to occur more frequently in certain types of individual (Muzj, Maj, and Luzj, 1955).

In order to examine these possibilities it would be necessary to extend the age-range of the study to include much younger children and also adult males and females. It is hoped to do this and thus enable more information to be gained concerning this problem.

Maxillary Length.—The results showed that only the female Cl. II, div. 1 group compared with the female controls had a significantly greater anteroposterior length of the maxilla. Björk's finding in boys with increased overjet suggested a slight increase in maxillary length. This was also the conclusion of Elasser and Wylie (1948) in their male group, but not in their female group. The present report differed in its conclusions in that only the females showed a greater maxillary length in the malocclusion sample, and as yet these differences remain unexplained. The fact that there was no significant difference in maxillary length between the male and female Cl. II, div. 1 groups again raises the question of a possible delay in onset of the prepubertal growth spurt in boys with Cl. II, div. 1 malocclusion.

Facial Height.—The increase in length of the upper and lower face in both Angle Cl. II, div. 1 groups appears well established, with the female group showing the greater increase. If the results regarding facial prognathism are considered, it is suggested that the profile in the male and female Angle Cl. II, div. 1 groups does not differ as regards the mean values of its component points, and it would follow that the greater increase in the females was due to a true increase in length rather than a greater degree of convexity of the face in the females.

As was mentioned earlier, Muzj, Maj, and Luzj (1955) have described some interesting work on the craniofacial patterns in differing types of constitutional build. One of their groups might be considered as being similar to the more extreme ectomorphic type of Sheldon, Stevens, and Tucker (1940), i.e., the tall, thin, angular individual. It is this ectomorphic group who show increased vertical dimensions, including those of the face, and Muzj and others have shown that they commonly have a Cl. II, div. 1 malocclusion. This is only a tentative explanation of the increase in the vertical linear measurements of the face, but it is a field which offers considerable possibilities for investigation.

Facial Prognathism.—Björk (1947) demonstrated that the maxilla in his Cl. II, div. 1 group (extreme overjet) of 12-year-old boys was very similar to his main sample as regards the degree of basal prognathism, while the mandible in his extreme overjet group was distal to that of his main sample. He concluded that it is not the protrusion of the maxilla which is a factor in the causation of postnormal occlusion, but rather the distal positioning of the mandible. When the results of the present study were examined it was found that the mean values for maxillary prognathism (∠SNA) were less in the Cl. II, div. 1 groups than in the controls by a significant amount. The mean values for mandibular prognathism (∠SNB) and the chin point (∠SNPo) were less than those for the controls by a very significant amount. This tends to confirm Björk's conclusions that it is the distal position of the mandible rather than forward positioning of the maxilla which causes the dental base discrepancy.

Björk's findings concerning maxillary and mandibular alveolar prognathism are also substantiated by the results of the present investigation in that alveolar prognathism closely follows basal prognathism. The present report has also confirmed that the chin point is closely related to the mandibular basal and alveolar prognathism.

Case's arbitrary classification of the Angle Cl. II, div. 1 malocclusion must therefore be re-examined. His concept of an individual with a normal relationship of maxilla to mandible in whom the malocclusion is produced by excessive forward positioning of the alveolar process and teeth in the maxilla (maxillary alveolar protrusion), or by excessive distal positioning of alveolar process and

teeth in the mandible (mandibular alveolar retrusion), is not substantiated by the evidence of the present study, at least in the great majority of the Cl. II, div. 1 sample. Similarly, the variation of facial pattern in which the whole maxilla is forward and the mandible is in normal relationship to the profile (maxillary protrusion) is uncommon in the Cl. II, div. 1 group examined. Only six individuals gave measurements of maxillary basal prognathism (∠SNA) which were greater than +1 Standard Deviation from the control mean value.

It is suggested, therefore, that the use of Case's classification is misleading since it tends to confuse the underlying causal factors of Cl. II, div. 1 occlusion. Case himself warned against the observer's eye being led astray by the position and shape of the overlying soft tissue. These may be expected to vary as much as the hard tissues, as Hopkin and McEwan (1956) have stressed, and it is only when cephalometric radiographs are employed that the soft-tissue variations can be discounted and a true assessment made of the skeletal structures.

It is suggested, therefore, that it is the relationship of the maxilla to the mandible which is the main factor in the causation of postnormal occlusion. It is the backward positioning of the mandible rather than forward positioning of the maxilla relative to the skull which is the principal discrepancy. The malrelationship of the maxilla and mandible is produced mainly by the cranial base structures, particularly in girls, but there is a tendency to reduced mandibular dimensions in the boys only. Both sexes in the Cl. II, div. 1 group show a slightly greater degree of alveolar prognathism in the maxilla compared with the controls, but mandibular alveolar prognathism, basal prognathism, and the chin point remain in close relationship in the great majority of individuals with Cl. II, div. 1 malocclusion.

SUMMARY

Tracings were made of the cephalometric radiographs of 50 boys and 50 girls, aged 7–14 years, with Angle Cl. II, div. 1 malocclusion.

A series of ten linear measurements and seven angular measurements for each individual was made from the tracings. The Mean Values, Standard Errors of the Means, and the Standard Deviations were calculated and the results compared with those of a previous study of 47 boys and 54 girls, aged 6–14 years, with normal or Angle Cl. I malocclusion. The '*t*' test of Snedecor (1956) was employed in this comparison.

The results were as follows:—

1. There was a significant increase in the overall cranial base length (N–Ar) and the anterior cranial base length (S–N) in the Cl. II, div. 1 groups compared with their controls. The posterior cranial base length (S–Ar) was significantly increased in boys only in the Cl. II, div. 1 sample.

2. The cranial base angle is more obtuse in both the Cl. II, div. 1 groups compared with their controls, more so in the girls.

3. No significant difference in mandibular dimensions, i.e., overall length (Ar–Gn), vertical ramus height (Ar–Go), horizontal ramus (Go–Gn), and mandibular angle (Ar–Go–Gn), was observed between the Cl. II, div. 1 groups and the controls. There was, however, a trend towards reduction in size in the male Cl. II, div. 1 group only. The significance of this is discussed.

4. A significant increase in maxillary length (ANS–PNS) was observed in the female Cl. II, div. 1 group only compared with its control. The male Cl. II, div. 1 group showed no significant difference from the male controls.

5. Facial height (N–ANS and ANS–Gn) was increased in both the Cl. II, div. 1 groups compared with the controls. There was a greater increase in the Cl. II, div. 1 girls.

6. Facial prognathism was recorded using angles based on the S–N line. It was found that it was mandibular retrusion rather than maxillary protrusion which produced the discrepancy in dental base relationship. It was also observed that alveolar prognathism in the maxilla (∠SNPr) tended to follow basal prognathism (∠SNA) in the majority of individuals with Cl. II, div. 1 occlusion, while alveolar prognathism in the mandible (∠SNId) was very

closely linked to the degree of basal prognathism (∠SNB). The chin point (∠SNPo) also closely followed basal prognathism of the mandible in the great majority of Cl. II, div. 1 cases.

The implications of these findings are discussed and their relevance to clinical observations is examined.

Acknowledgements.—Acknowledgements are due to Dr. G. B. Hopkin, Senior Lecturer, Orthodontic Department of the University of Edinburgh, for his constant encouragement and well-informed criticisms; to Dr. J. N. Mansbridge, Senior Lecturer, Department of Public Health of the University of Edinburgh, for his assistance in the analysis of the statistical data; to Miss M. Benstead, Medical Artist, for the diagrams; to Mr. R. Renton for photographic assistance; and last, but by no means least, to Miss M. Miller for her willing secretarial assistance.

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DISCUSSION

Dr. J. R. E. Mills said that it was very valuable to have the average picture of a Cl. II, div. 1, but would not the author find it interesting now to go back to his tracings and try to analyse individual cases? It would make an interesting paper if he were to come back and show perhaps the extreme examples.

The average individual has a large cranial base and a large saddle angle, taking the mandible farther back. He suggested that this was not so in every case and that some individuals would be found who had a Cl. II, div. 1 occlusion because they had a small mandible, and there were others with a large maxilla and nothing else.

Mr. G. A. James said that this was always the problem in any such study and he was well aware of the snags of mean values. He had tried to go back and assess individual cases of Cl. II, div. 1. Some of the factors, such as increase in over-all cranial length, appeared in a great majority of the individuals. Occasionally, there was an isolated instance of an individual with maybe a small mandible only, and he was working at the moment on differential analysis, trying to tackle it in various ways with different features out of harmony, and seeing how the other measurements compared.

He had assessed many individual cases and had tried in the paper to give the impression that very few individuals had only one measurement out of harmony. This point had been made again and again by many people doing this type of analysis.

Dr. W. J. Tulley asked whether Mr. James had applied Moorrees's grid system in analysing any of these things.

Mr. G. A. James said that he had tried Moorrees's system, but not in this particular instance. He knew it was an extension of Durer's facial system and he thought perhaps the trend in the future would be towards the grid system, but it was a very laborious method, as Dr. Tulley would confirm, and to do it for 100 cases would take a very long time.

He had been working with someone else's control. The method was basically that of Björk. Many of his measurements were based on Björk's work and therefore followed his line of approach.

EARLY TREATMENT OF A PRENORMAL MANDIBLE

By LILAH M. CLINCH, SC.D., F.D.S., D.ORTH. R.C.S.

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THIS case is presented because it was treated at a very early stage of development and had treatment been postponed it is doubtful if a satisfactory result could have been achieved.

The case history is given as written on the record card from when the patient was first seen.

CASE REPORT

J. S.—Age 5 years 11 months. Average height and weight.

All deciduous teeth firm. The lower right first molar only permanent tooth through gum.

There was no history of prenormality of mandible in family. Speech has always been indistinct. Very slow eater.

PROFILE AND FACIAL CONTOURS.—Prenormal position of mandible. Broad mandibular base. Flat in premaxillary area. Lips slightly apart.

DIAGNOSIS.—

Bases.—Supernormal mandibular base.

Arches.—Subnormal maxillary arch anteroposteriorly. Supernormal mandibular arch in incisor area (*Fig.* 1).

Relationship.—Prenormal occlusion of mandibular arch.

Malpositions.—Mandibular incisors and canines labial to maxillary teeth. Linguoclination of maxillary incisors. Spacing of mandibular incisors and canines. Deep overbite of mandibular incisors over maxillary (*Fig.* 2).

TREATMENT.—Head-and-chin cap. Reverse intermaxillary traction with labial movement of maxillary incisors and retraction of mandibular incisors.

PROGNOSIS.—Bad, but no family history of prenormal mandible.

As the condition could not improve without treatment, and as the speech and mastication were poor, it was decided that an attempt should be made to reduce the malformation.

A head-and-chin cap was worn at night and for some hours each day for two years and at night only for a further four and a half years. In addition a series of upper and lower incline plates were worn day and night; the upper plate had a lingual spring to move the incisors forward and the lower had a buccal arch to retract the incisors. These were worn between the ages of 6 years and 9 years 4 months; for a further fourteen months until the age of $10\frac{1}{2}$ years, a lower plate only was worn. All appliances were removed at $10\frac{1}{2}$ years, except the head-and-chin cap which was worn at night until $12\frac{1}{2}$ years of age. The patient was extremely co-operative, and, strange to say, did not object at all to the head-and-chin cap. (*Fig.* 3.)

The patient was seen again at $13\frac{1}{2}$ years of age and the occlusion was, if anything, more stable than it had been the previous year (*Fig.* 4).

Finally, *Fig.* 5 shows snapshots taken at 18 months, at 6 years (when treatment started), and at 14 years of age (three years after the removal of the last plate and eighteen months after the removal of the head-and-chin cap).

DISCUSSION

Mr. M. A. Kettle asked if Dr. Clinch took lateral X-rays before and after treatment, and, if so, what were the findings.

Dr. L. M. Clinch said that she did not.

Mr. W. A. B. Brown asked Dr. Clinch what was the basis of her comment, 'the dentition could not improve without treatment'. He felt that correction of the malocclusion might be largely due to normal growth.

Dr. Clinch said that she had absolutely no proof that the condition would not have corrected itself except for her clinical experience and common sense. The trend up to the age of 6 years at any rate was not normal. It might have changed just at that period, but this was doubtful.

Mr. A. J. Walpole Day asked if Dr. Clinch could say what she thought brought about this very desired result, and would she also say a little more about the soft tissues? Dr. Clinch mentioned the speech defect and difficulty with chewing but she did not say how the speech improved or how the eating improved. Was there any history of defective tonsils or adenoids?

Dr. L. M. Clinch said that the mastication and the speech became quite normal. There was no history of a prenormal mandible in the family at all. She did not know what might have caused the malocclusion. The tongue was certainly lying very low in the mouth, as Mr. Walpole Day suggested, and the speech therefore

Presented at the Country Meeting held at Norwich on 17 May, 1963.

was slurred. The child had not had her tonsils or adenoids removed.

Mr. A. C. Campbell asked if Dr. Clinch was able to assess in the first instance whether the child could have pulled the mandible back towards an edge-to-edge incisor relationship.

Dr. Clinch said that it would be hard to say that there was no postural element, but she would not have said it was a postural Class III.

Dr. R. B. Dockrell asked Dr. Clinch whether she thought much contribution was made by the reverse intermaxillary traction. He had a case some years ago presented to him at about 4 years of age. The same case came back at the age of 5 years and 11 months, by which time the negative overjet had increased alarmingly. In order to keep the child happy he decided to put on the chin cap and occipital anchorage. When at the age of $7\frac{1}{2}$ years the upper permanent incisors came down they were in contact with the lingual surfaces of the lower incisors, so he just put in a plate and then left the child on the same occipital anchorage. He was inclined to wonder whether intra- or extra-oral treatment had any effect at this stage.

Dr. Clinch said that it was hard to say whether an inclined plane had any effect beyond keeping the bite open. She thought probably the lingual spring behind the incisors really had most of the effect of improving the incisor relationship.

Dr. W. J. Tulley said that he had a case rather similar to Dr. Dockrell's which it was proposed to treat by chin cap and to raise the bite with an overlay on the posterior teeth. He had fitted the upper plate with overlays on the posterior teeth, and trimmed it down so that the overbite was just about negative, and he then sent the patient away for a month before constructing the head cap. When the patient came back the upper incisors were over the bite and there was considerable overbite.

Dr. Clinch said that if the incisor overlap had been corrected by a plain overlay in her case she would have said that a bimaxillary protrusion had been produced because there was a great protrusion of the lower incisors.

Mr. C. P. Adams said that he had a patient of about 5 years of age with a very marked Class III occlusion in the deciduous dentition. The patient was seen at 6-monthly intervals. When the permanent incisors came through there was an underjet of about 5 mm. and there was every indication of no eventual overlap of the incisors. Six or nine months later the incisor relation had improved markedly, so much so that by a slight movement of the upper and lower incisors in the respective directions a correct incisor relation was obtained by very simple means. That had substantially remained. It was his impression that this was a purely alveolar change.

Mr. H. L. Leech said that he noticed that in this case there was some spacing in the premolar region in the lower jaw. Would Dr. Clinch have carried out the same treatment if there had not been that spacing? He had seen a case where early treatment had been carried out mainly by pushing the upper incisors over the lowers. The case was seen four years later, and X-rays showed that there had been marked resorption of the roots of the upper incisors. In these cases early treatment could be dangerous.

Dr. L. M. Clinch said that when she last saw the child, which was a year and a half after all appliances had been removed, there was no sign of a looseness of the upper incisors.

Mr. J. S. Rose did not think that crowding in this particular type of case had any relevance. He thought the question of trauma to incisors in the cases mentioned might well have been due to overproclination, and this was, as had been agreed, a dangerous thing.

Mr. H. L. Leech said that he agreed that these upper incisors were overproclined into a traumatic bite, and that was why the resorption took place. He thought that Dr. Clinch's case should have been left until two lower premolars could have been extracted and the lower incisors retroclined rather than the upper incisors proclined.

Mr. H. G. Watkin asked Dr. Clinch why she used plates instead of a lingual bow with a spring.

Dr. L. M. Clinch said that she used plates to reduce the overbite.

Mr. H. G. Watkin said that the same thing could be done with a wire attached to the lower teeth. When it was put into buccal tubes it would depress the incisors permanently.

Mr. B. B. J. Lovius asked Dr. Clinch what she meant by her statement that one year afterwards the patient had a more stable relationship.

Dr. Clinch said that the interdigitation seemed to be more favourable at 14 years of age than it had been at 13, particularly when comparing the two sets of models.

Mr. G. A. James asked if the patient had completed her adolescent growth. This was the time when it either held or did not.

Dr. Clinch said that her impression was that the patient had completed the adolescent growth.

Mr. J. F. Pilbeam asked if there was any history of injury at birth.

Dr. Clinch said that there was no history.

Mr. H. E. Wilson recalled a patient whom he saw at the age of 1 year. Both parents were Class III, and the child was very like her mother. He had explained the position to the parents and said he would try to do something, and that patient was corrected very quickly. She had a young sister who was just like the older sister at the age of 1 year. The older sister was so successful that the same head cap and plastic chin cap were used for the sister, with the same sort of rapid success. He had seen these children until they were 4 or 5 and they were then normal.

Mr. A. W. Greenwood said that he was not quite clear whether Dr. Clinch obtained a great improvement in the reverse overjet during the remainder of the deciduous dentition stage or whether she had to wait for the permanent incisors to erupt.

Dr. L. M. Clinch said that she treated the case in the deciduous dentition and the permanent incisors erupted into a normal relationship.

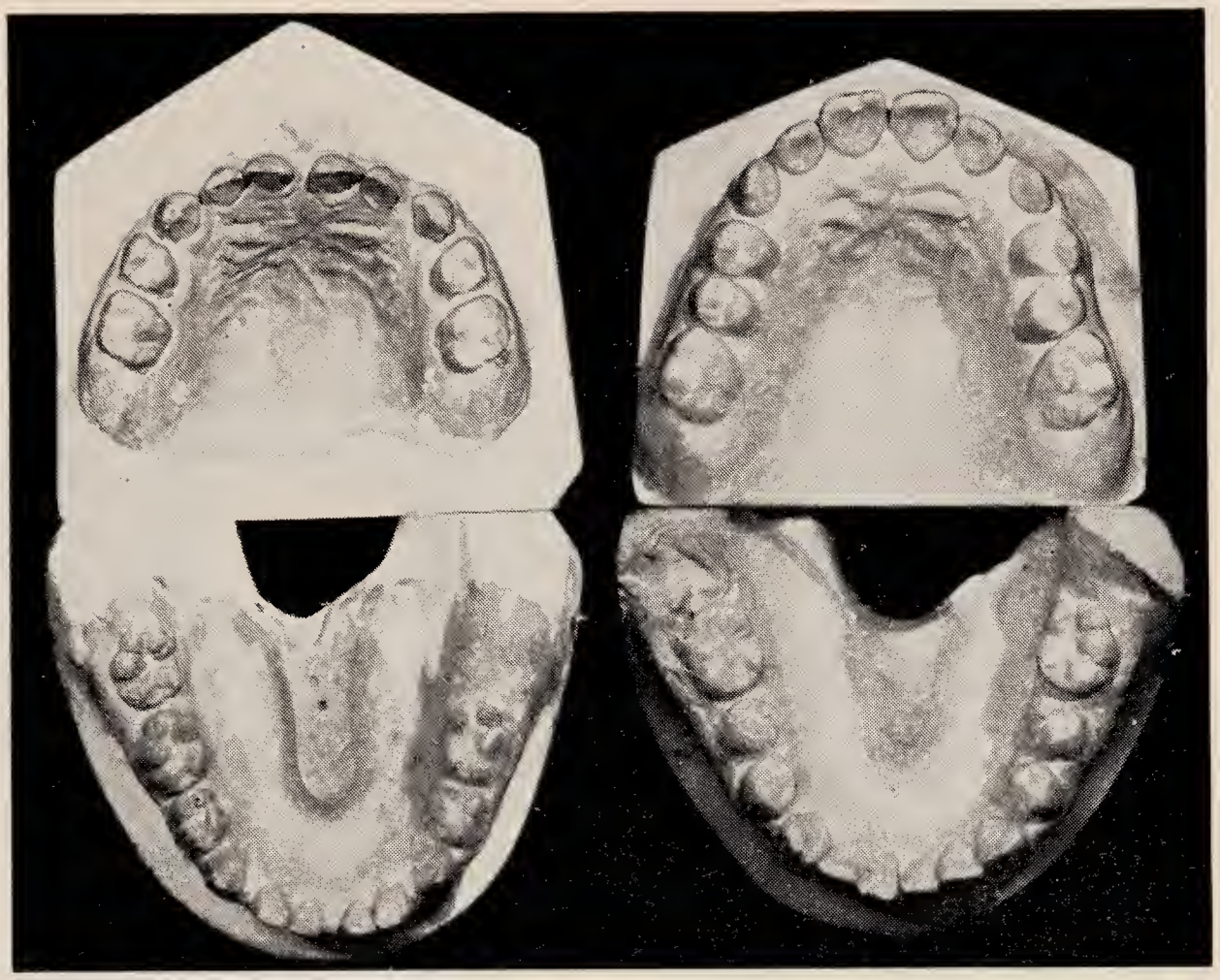

Fig. 1.—Occlusal views of models immediately before treatment and immediately after removal of appliances. (At ages 5 years 11 months and 10 years 6 months.)

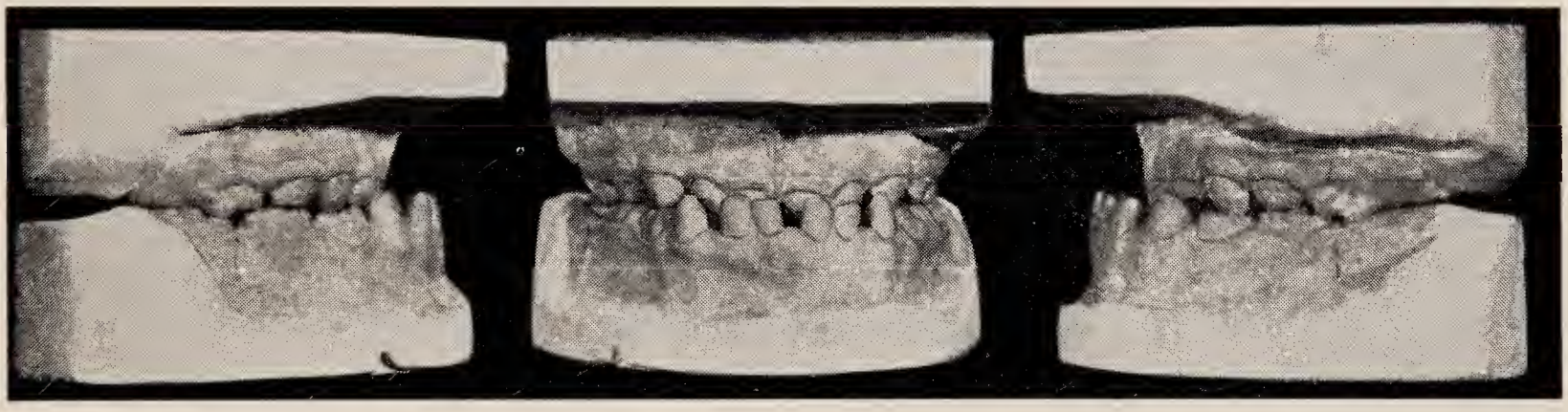

Fig. 2.—Front and profile views of models in occlusion (at age 5 years 11 months) showing disproportion between the arches and the prenormal occlusion of the mandibular arch.

Fig. 3.—Front and profile views of models in occlusion (at age 10 years 6 months).

Fig. 4.—Profile views of models in occlusion (at age 13 years 6 months).

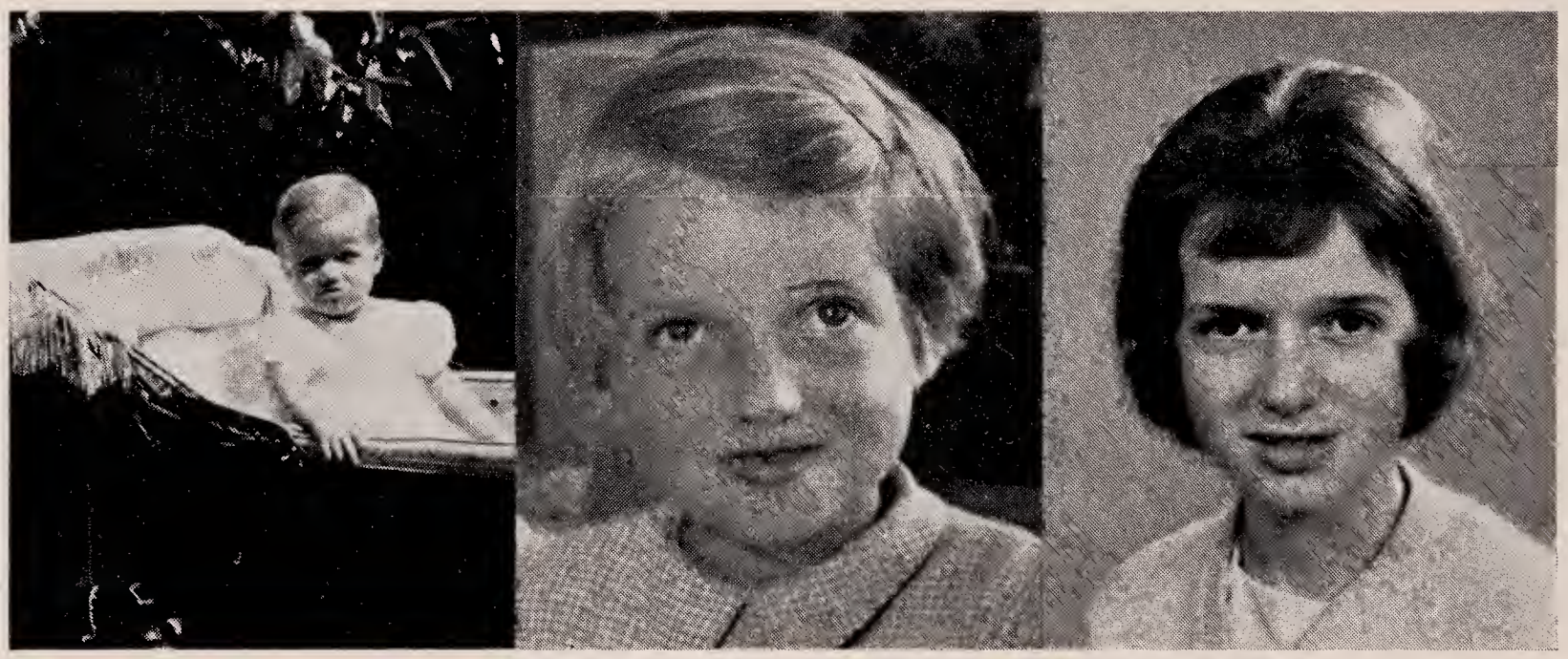

Fig. 5.—Photographs taken at ages 18 months, 6 years, and 14 years.

CASES ILLUSTRATING SPONTANEOUS CHANGES IN THE DENTAL ARCHES DURING THE FIRST NINE YEARS OF LIFE

By B. C. LEIGHTON, M.D.S., H.D.D., D.ORTH. R.C.S., D.D.O.
University of London, King's College Hospital Dental School

DURING the course of a longitudinal study of dental development it was found that a number of early malocclusions showed spontaneous changes of severity during the deciduous dentition stage. Most of these have now been followed up into that of the mixed dentitions, and serial study models of a selection of them have been shown. Most of the changes would have been difficult to forecast. They may arise

Fig. 2.—*Case* 271. Occlusal view of models of case shown in *Fig.* 1 to demonstrate dome shape of deciduous molars.

Fig. 1.—*Case* 271. Development of a buccal occlusion of left side at time of eruption of first deciduous molars. This was associated with postnormal occlusion and deviation of the mandible to the right. The deviation and the buccal occlusion were resolved spontaneously between 30 and 42 months, but some degree of postnormality returned later.

A Demonstration presented at the Country Meeting held at Norwich on 17 May, 1963.

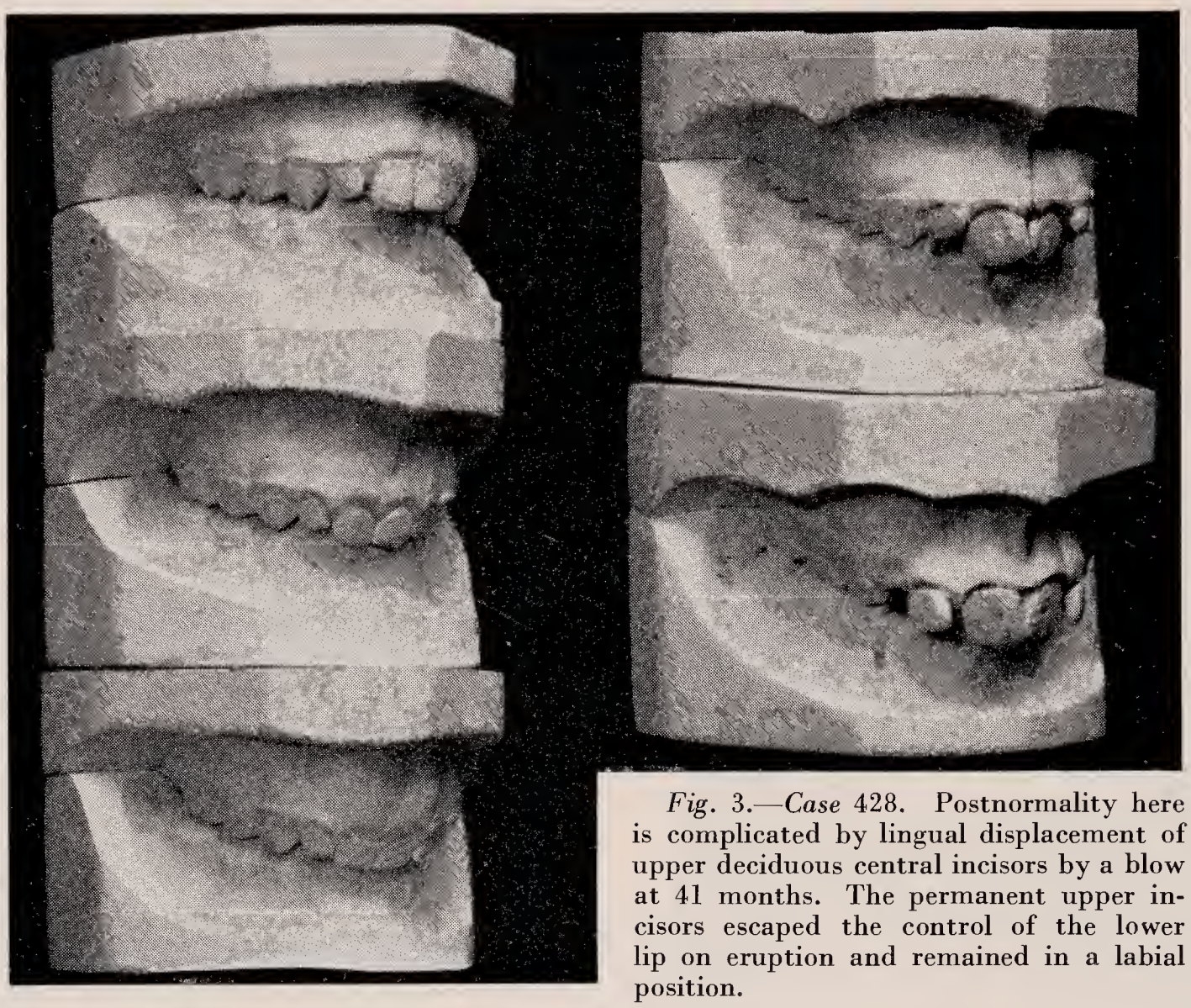

Fig. 3.—*Case* 428. Postnormality here is complicated by lingual displacement of upper deciduous central incisors by a blow at 41 months. The permanent upper incisors escaped the control of the lower lip on eruption and remained in a labial position.

Fig. 4.—*Case* 116. Series of models to show the development of a characteristic type of Class II, division 2 malocclusion. Note the persistently deteriorating lingual inclination of the upper incisors.

as a result either of alterations in mandibular position or of persistent muscular forces.

It is not unusual to find a sudden change of arch relationship occurring, particularly at the time of eruption into occlusion of second deciduous molars, but it may also occur when the first permanent molars erupt. These have been described by Bonnar (1956), and by the author in a previous paper (Leighton, 1960), where the thesis was put forward that spontaneous changes of the position of maximum intercuspation may be stimulated by premature contacts arising from newly erupted teeth. It is very possible that reverse changes may occur more gradually as cusps of deciduous teeth become worn down.

In *Case* 271 (*Fig.* 1) a buccal occlusion of the upper molars on the left side dated from the time when the first deciduous molars erupted. This was associated with postnormal occlusion and deviation of the mandible to the right on closure. It was noticed here that all the deciduous molars were of a dome shape, having small occlusal surfaces with well-marked slopes to the buccal and lingual aspects (*Fig.* 2). This was doubtless a factor in encouraging the buccal occlusion. Although the occlusion had become almost normal between the ages of 30 and 42 months there was subsequently some relapse to a mild postnormality, but the buccal occlusion and deviated path of closure have not returned.

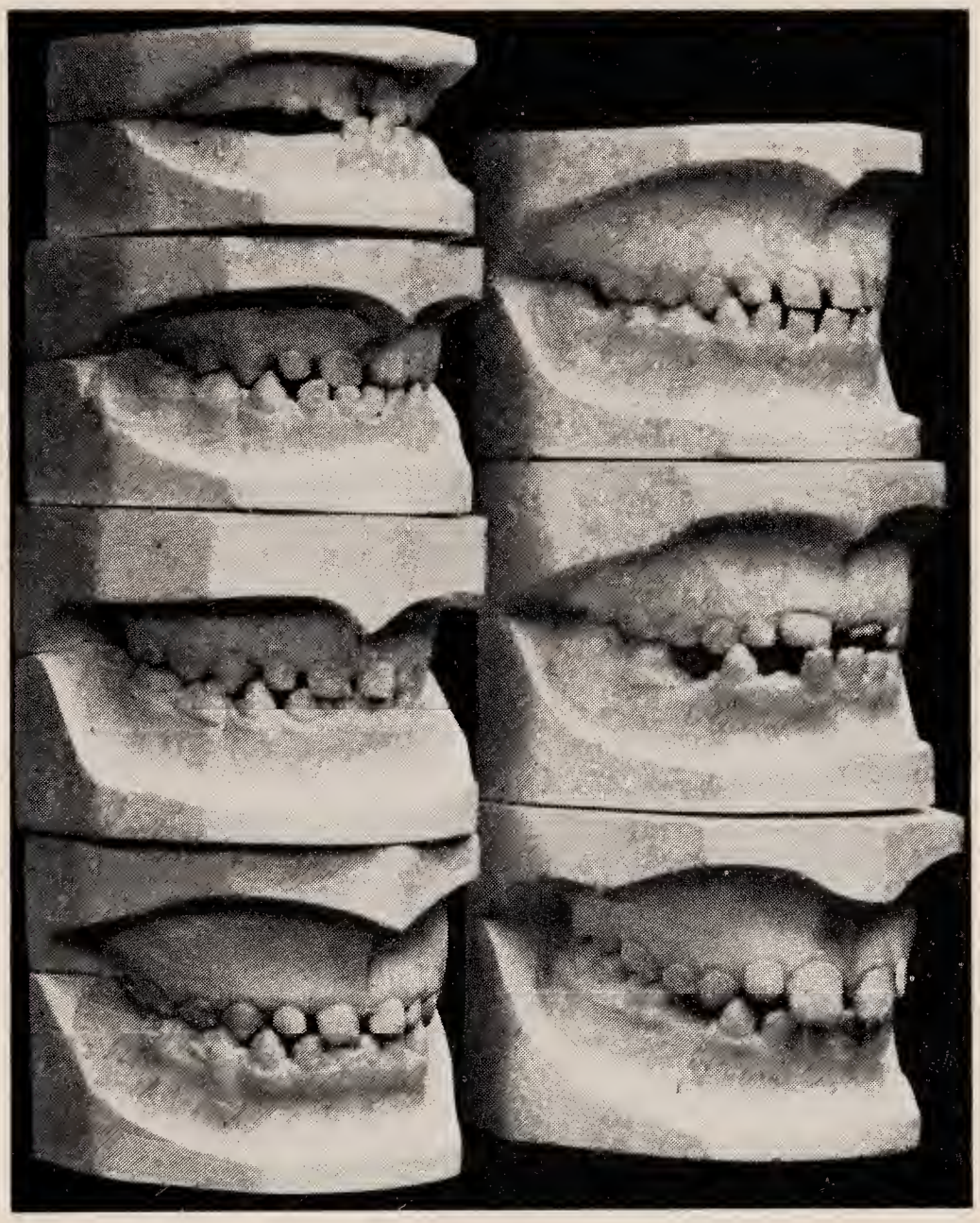

Fig. 5.—*Case* 342. Mild prenormal case in which lingual occlusion of deciduous incisors and later permanent incisors becomes resolved spontaneously.

The interplay of skeletal form and muscular forces may cause slow but progressive changes of tooth position in either or both arches. This is seen most frequently in the incisor region.

A case of postnormal occlusion (*Case* 428) (*Fig.* 3) is described, where a blow at 41 months caused the lingual displacement of the upper deciduous central incisors to a position where they came under the influence of the lower lip. During the next two years these teeth became

inclined more lingually, giving the appearance of a Class II, division 2 occlusion. The erupting permanent incisors, however, emerged in a position labial to the lower lip, where they have remained, the overjet increasing during the next two years. It would appear, therefore, that the displacement of deciduous incisors had no effect on the final position achieved by the permanent incisors.

In *Case* 116 (*Fig.* 4) the incisor overjet was initially rather excessive (5 mm.), but became reduced to 2 mm. by the age of 44 months. There was subsequently further inclination of deciduous and then permanent incisors, assisted by some lower extractions, producing a malocclusion which is a characteristic type of Class II, division 2. The inevitability of this outcome is suggested by the fact that from an early age this boy showed other characteristics of a Class II, division 2 malocclusion; namely, a low Frankfurt-mandibular-plane angle, deep incisor overbite, well-marked zygomatic arches, and a definite activity of orbicularis oris muscle on swallowing.

A further case (*Case* 342) (*Fig.* 5) started with a mildly prenormal occlusion and lingual occlusion of the upper deciduous incisors. This became corrected spontaneously between 29 and 42 months. The incisor malrelationship was again threatened when the permanent incisors erupted, but once more improved spontaneously, being associated with an unusually large increase (4 mm.) in the length of the anterior part of the upper arch. Activity of the tongue against the lingual surfaces of the incisors was noticed from an early age, and probably contributed to the improvement seen in their relationship.

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ABNORMALITIES IN A NUMBER OF TEETH

By ANTHONY WESTBROOK, L.D.S. R.C.S.

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The following cases were shown to illustrate some of the less common variations in tooth number. It is generally agreed that the permanent teeth most frequently additional in the arch are the conical upper mesiodens or midline supernumerary teeth. In order of frequency, there also occur unilateral or bilateral tuberculate supernumeraries on either side of the midline, supplemental upper laterals, and additional molar teeth.

It is, however, more frequent to see a permanent tooth or teeth absent from the dental arches, and here again opinions agree that the laterals, the second premolars, then the third molars, are the order of frequency of occurrence.

CASE REPORTS

Case 1 presented a borderline Skeletal II base with a favourable soft-tissue pattern. Space had been lost for the $\underline{1}|$ and the $\underline{A}|$ was retained until the age of 10 years.

On radiological examination, the $\underline{1}|$ was present (unerupted), and there was a tuberculate supernumerary on that side of the midline: $\frac{8|8}{8|8}$ were present (unerupted), and a supplementary $\overline{8}|$ was also present at the same stage of development and calcification as the $\frac{8|8}{8|8}$. This supports the aetiological theory that a tooth germ of the normal series has undergone dichotomy (equal division). (*Fig.* 1.)

Case 2 presented a Skeletal I base with a tendency to an Angle's Class II, division 1 malocclusion, and clinically, delayed eruption of the upper right permanent central incisor; there was a persistent family history of the occurrence of supernumeraries.

A Demonstration presented at the Country Meeting held at Norwich on 17 May, 1963.

On radiological examination, the $\underline{1|}$ was found to be present (unerupted), and two conical mesiodens present; one positioned normally in the midline, the other completely inverted. (*Fig.* 2.)

Cases 3 and 4 (identical twins) presented Skeletal I bases and favourable soft-tissue patterns.

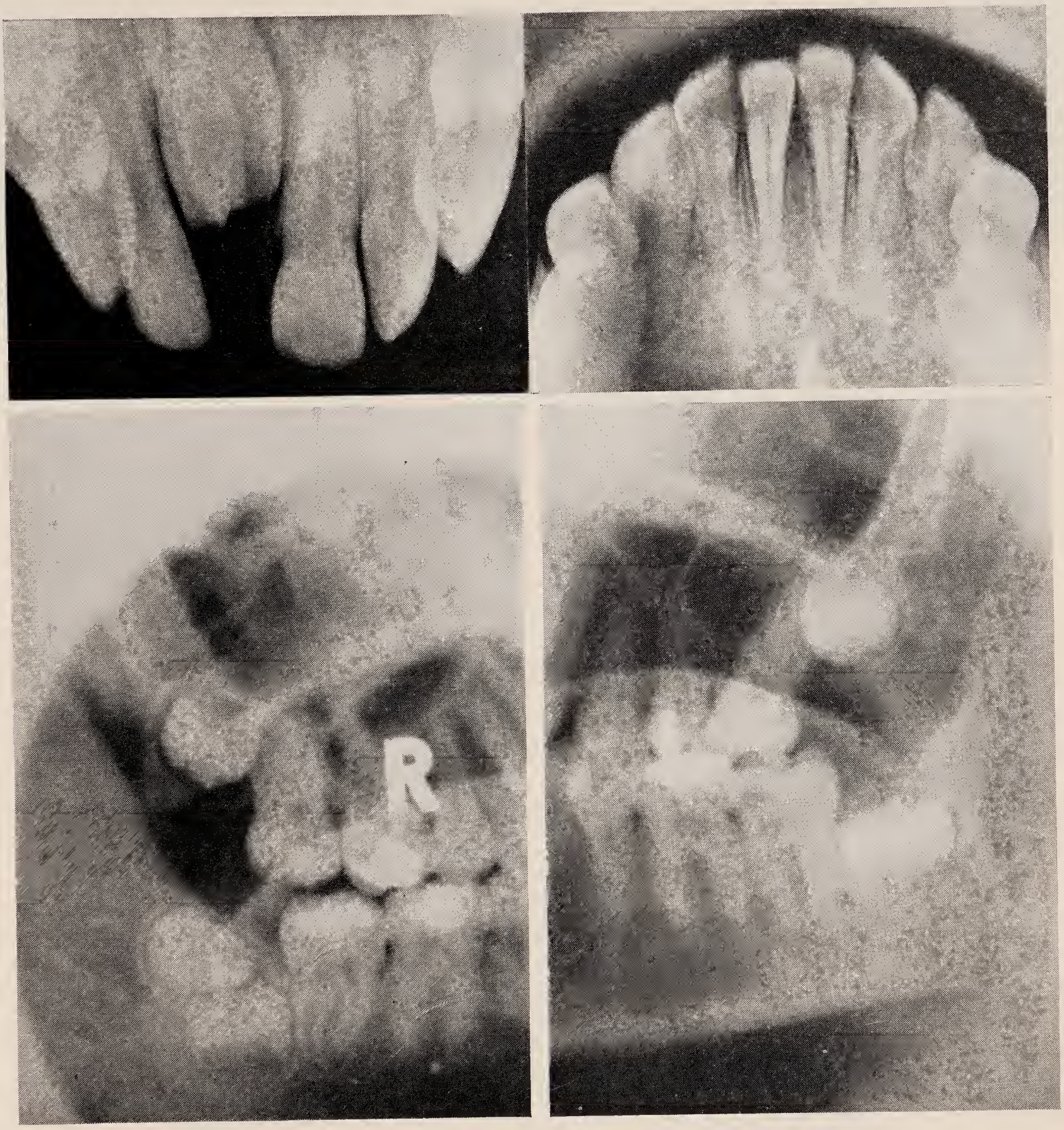


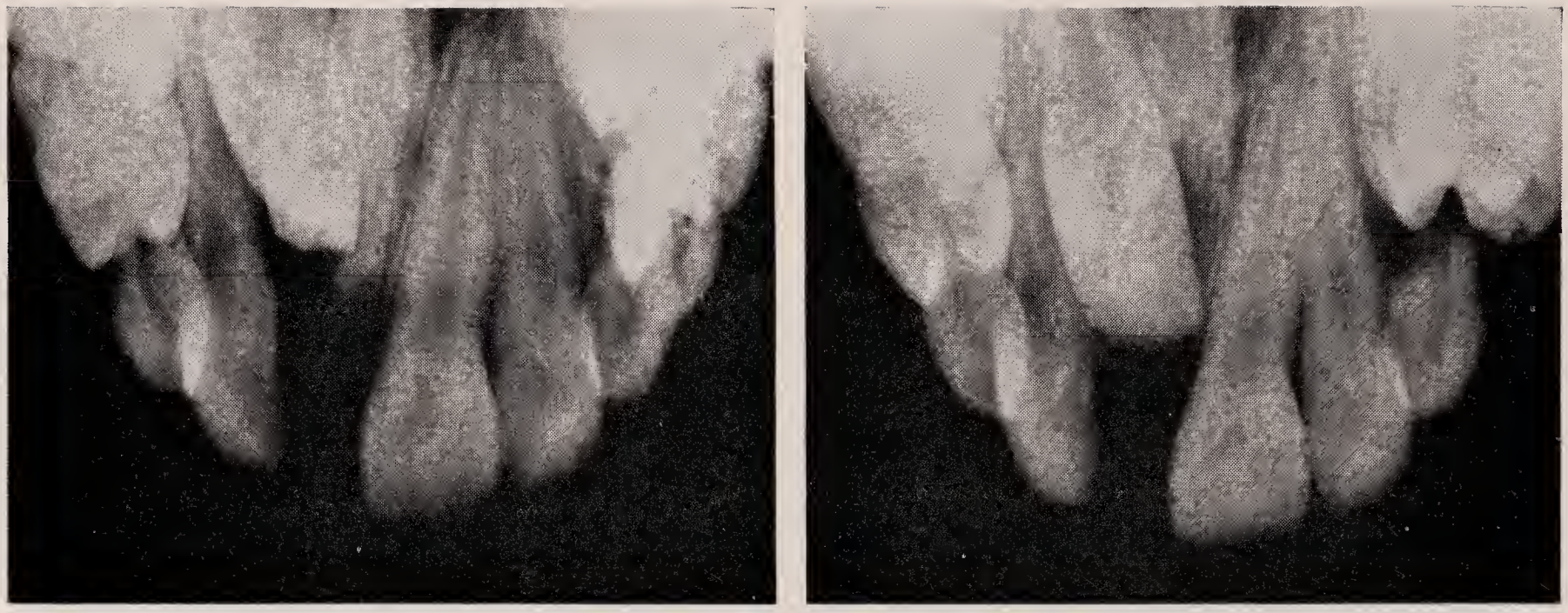
Fig. 1.—*Case* 1. Tuberculate supernumerary midline, supplementary $\overline{8|}$ (dichotomy).

On radiological examination, both patients showed the presence of additional upper third permanent molars, and 'G' provided evidence of rarefaction (? tooth crypt) distal to the $\overline{|8}$, while 'R' showed an additional lower left fourth permanent molar ($\overline{|9}$), developing and calcifying distally in the anterior border of the ascending ramus. In view of the retarded stage of development and calcification of this tooth, it is aetiologically most probably due to the formation of an additional tooth germ derived from excessive growth of the dental lamina. (*Fig.* 3.)

Case 5 presented a Skeletal II base with a slightly unfavourable soft-tissue pattern. There were family histories of Class III tendency, spacing of large central incisors, and small conically shaped teeth.

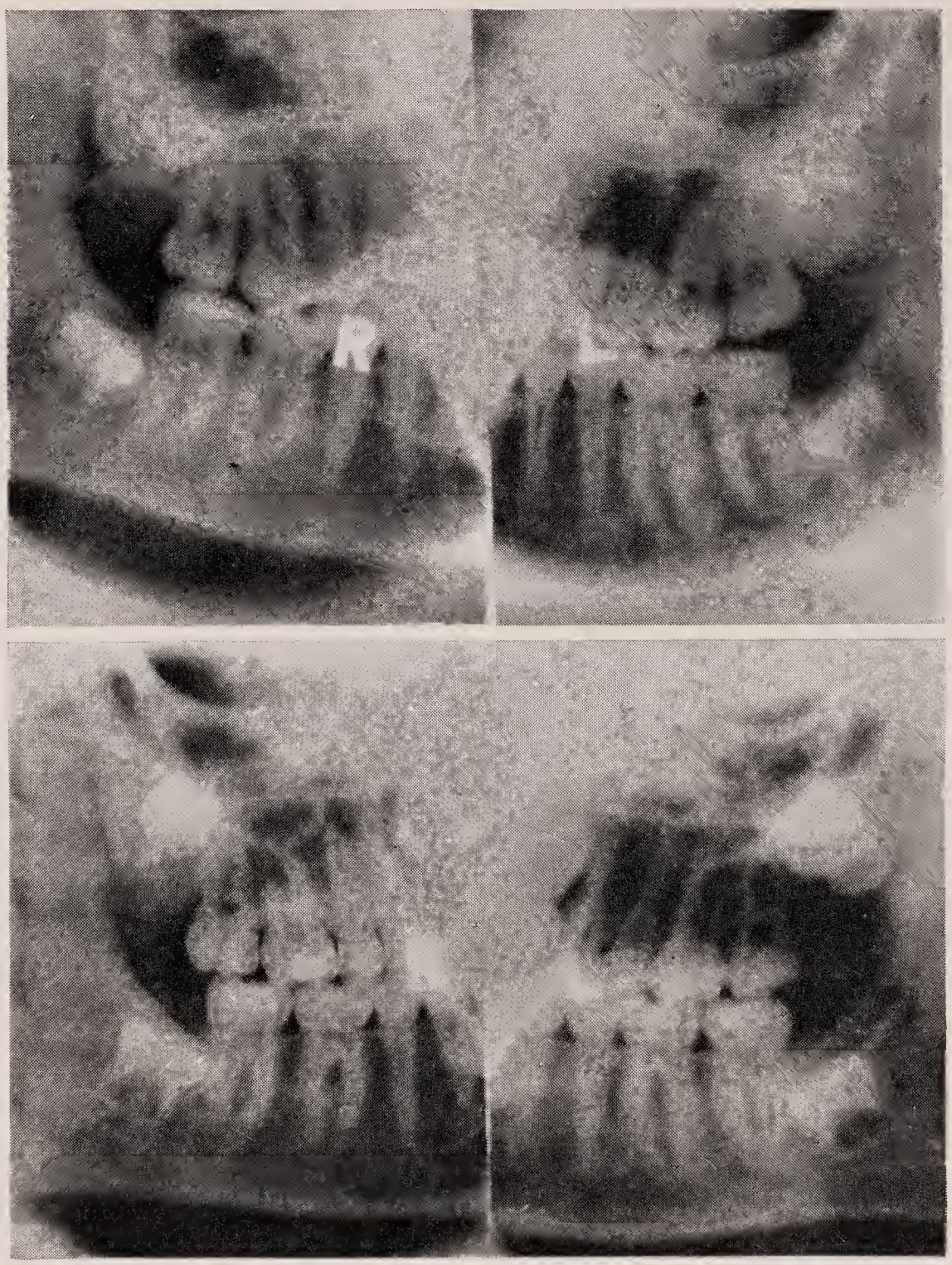
On radiological examination, the $\frac{32\ |\ 23}{321|123}$ were absent, the $\frac{7|}{7|7}$ were present (uneruptcd); $\frac{8\ |8}{85|8}$ were absent.

On clinical examination, the measurements of $\underline{1|1}$ were each 7·5 mm. wide, and the distance between their mesial surfaces was 6·0 mm. There was apparently no association with any further form of ectodermal dysplasia,



A B

Fig. 2.—*Case* 2. A, Delayed eruption $\underline{1|}$, conical mesiodens, one normal, one inverted. B, $\underline{1|}$ erupting normally following removal of supernumeraries.



A

B

Fig. 3.—*Cases* 3 and 4.—A, Twin 'G', showing possible crypt of supernumerary molar distal to $\overline{|8}$. B, Twin 'R', showing calcifying $\overline{|9}$.

Fig. 4.—*Case* 5. Partial anodontia.

giving rise to abnormalities of the nails, skin, hair, or sweat-glands. (*Fig.* 4.)

Acknowledgements.—I would like to record my grateful thanks to Mr. N. G. Le Page of the Photographic Department, Neuro-Pathological Laboratory, Queen Mary's Hospital for Children, Carshalton, Surrey; to Sister J. M. Benns, of the Dental Department, and to Nurse A. M. Purdue for their valuable assistance and enormous patience; to Mr. R. E. Box for his technical skill and assistance, and to Mrs. E. Farmer for her secretarial assistance.

SELF-TREATMENT OF MALOCCLUSION

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INTRODUCTION

PATIENT co-operation is of the utmost importance in orthodontic treatment. The orthodontist relies very much on his patients to play their part in their own treatment by conscientiously keeping appointments, wearing, and in some cases adjusting, appliances, and maintaining proper oral hygiene and regular dental care. Occasionally, a good patient can be instructed to perform his or her own treatment of a very simple malocclusion, an example being the proclination of an instanding upper incisor by levering with a wooden spatula.

Fig. 1.—Patient before self-treatment commenced.

Fig. 3.—Lateral oblique radiographs, showing the absence of all the second premolars.

Fig. 2.—Models of the dentition before self-treatment.

Patient co-operation can, however, go much farther than this, as is shown by the following report.

CASE REPORT

HISTORY.—A patient, a boy aged 11 years 1 month, was referred for orthodontic treatment. On examination, it was found that he had an Angle Class II, division 1 occlusion on a Class II dental base relationship. His lower lip rested behind his upper incisors and contracted

Presented at the Country Meeting held at Norwich on 18 May, 1963.

behind the upper incisors on swallowing, putting backward pressure on the lower incisors. The lower incisors were retroclined, and the upper incisors were proclined and spaced (*Figs.* 1, 2). The incisal overbite was increased,

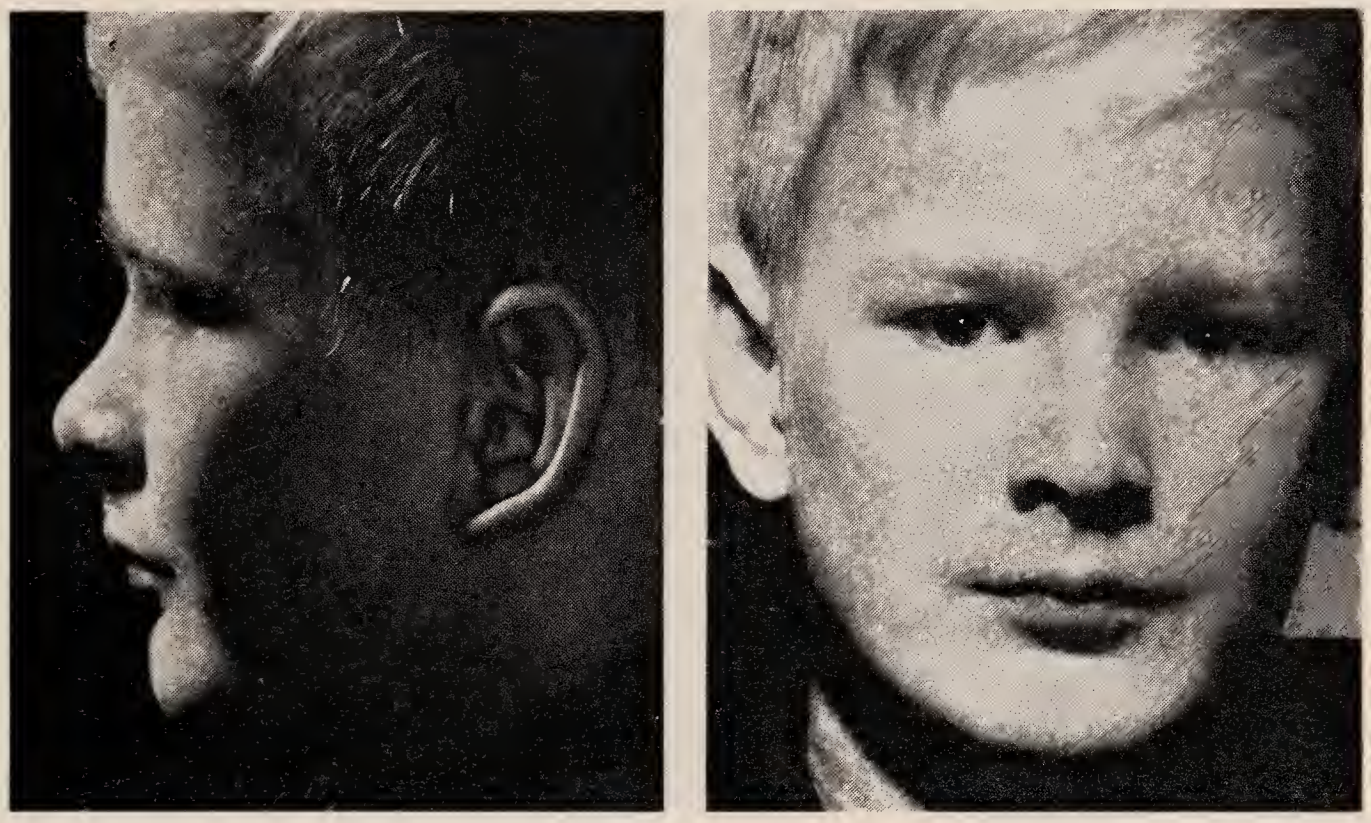

Fig. 4.—The patient after self-treatment.

with the lower incisors biting on the palate immediately behind the upper incisors.

He had at that time $\frac{6421|12C46}{6C21|12C\ 6}$ erupted in the mouth, and radiographs revealed that $\frac{7\ 3|3\ 78}{8743|3478}$ were unerupted and that $\frac{5|5}{5|5}$ were missing (*Fig.* 3).

It was decided to delay orthodontic treatment until the eruption of the permanent upper canines, and the patient was therefore reviewed at intervals until he was 11 years 11 months old. At that time his permanent upper canines were still unerupted, and he was given another appointment for review. However, owing to a series of events, the patient did not attend for another year, by which time he was just 13 years old.

On examination on this occasion, it was found that he no longer had a Class II, division 1 occlusion, but had a Class II, division 2 type of occlusion which appeared to be so good as to require no treatment (*Figs.* 4, 5).

Questioning of the boy revealed that at the previous visit, one year before, he had listened to an explanation being made to his mother that for treatment to be successful in his case it would be necessary to retract his upper incisors so that they were covered by his lower lip. Without saying anything to anyone, he had determined to try to do the treatment himself, and every night when he went to bed he had therefore postured his mandible forward so that his lower incisors were in front of his upper incisors, and tried to drop off to sleep with his jaw in that position. As a result, he had very successfully treated his malocclusion himself.

Fig. 5.—Models of the dentition after self-treatment.

THE REQUIREMENTS FOR SELF-TREATMENT

The ease with which treatment had been carried out in this patient led to an examination of the main relevant features of the boy's orofacial structure, with a view to deciding the factors necessary for such self-treatment.

The first and most obvious feature is the lack of crowding of the dentition. In this case,

the fact that $\frac{5|5}{5|5}$ were missing was fortunate, although, of course, teeth can always be extracted if they are not congenitally missing.

It became apparent after the patient had treated himself that his lips were able to meet

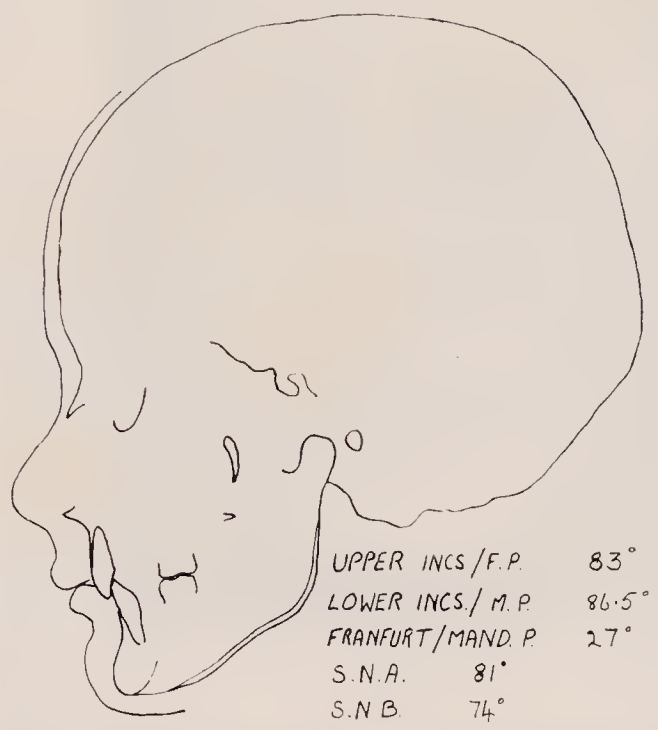

Fig. 6.—Tracing from a lateral skull radiograph taken after self-treatment.

whilst in the resting position, that is, before treatment they were what is often called 'potentially competent'.

The form and relationship of the jaws are shown in *Fig.* 6. There was a mild degree of Skeletal Class 2. The Frankfurt-mandibular-plane angle was 27°, which is considered to be more or less ideal. After self-treatment, the upper incisors were retroclined, being at an angle of 83° to the Frankfurt horizontal plane, and the lower incisors were very slightly retroclined, at an angle of 86·5° to the mandibular plane.

It is apparent that, apart from the Skeletal Class 2, the patient's orofacial structure was ideally suited to normal occlusion.

The boy also appeared to be alert and intelligent and indeed his school record showed him to be well above average in this respect.

DISCUSSION

Complete self-treatment as described here, without even any direct advice from the orthodontist to the patient, appears to be a rare occurrence. It would seem that for such self-treatment to be successful, the factors which go to make up a normal occlusion should be present from the beginning, or at least any deviation from ideal orofacial structure should be slight. The patient's intelligence is probably also an important factor.

It is interesting to speculate on how the malocclusion originally developed. There was no history of thumb- or finger-sucking habits, and no definite evidence could be found as to why the upper incisors originally became proclined instead of retroclined when they erupted.

Finally, it would be very interesting to see whether other patients with similar characteristics could be persuaded to treat themselves in a similar way.

AN ORTHODONTIC SURVEY OF THE ISLANDERS OF TRISTAN DA CUNHA

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TRISTAN DA CUNHA is a group of three islands situated in the South Atlantic Ocean almost midway between the South American and South African Continents. Volcanic in origin, they are far removed from the world's shipping routes and take their name from the Portuguese navigator who discovered them in 1506.

The largest island, bearing the same name as the group, is circular, about six miles wide, rising to a peak of some 6700 feet. It is the only one inhabited and this habitation dates from the beginning of the nineteenth century to 1961, when in October of that year volcanic eruption caused its complete evacuation.

EARLY HISTORY

Tristan was first officially occupied in 1816 when the British Government established a garrison there from Cape Town. This was shortly after the war with France, and its purpose was to forestall any attempt that might have been made from the island to release Napoleon from exile in St. Helena, 1200 miles to the north-east. Owing to its geographic situation, however, supplying the island was difficult, and the Governor of the Cape withdrew the garrison a year later. A corporal named Glass, his wife, and two of the men who had worked on the fortifications requested permission to stay. This was granted and the social history of the islanders began.

During the next ten years Glass and his wife were joined by several settlers from the Cape, including an ex-sailor named Swain with his wife, and various shipwrecked mariners, increasing the number on the island to eleven, comprising seven men, two women, and two children.

As there were five bachelors in the group and they wished to establish their community it was decided to obtain wives, and five coloured women were sent from St. Helena. Thus the original community came to include stock of African and Malayan racial origin. By 1890 other shipwrecked sailors had joined the island, including two Italians named Repetto and Lavarello and several American whalers who stayed and married daughters of the original community, so that today it is genetically a very heterogeneous group.

SOCIAL HISTORY

Briefly, there are three main phases in the history of Tristan and the islanders. When first populated it was on the South Atlantic sailing routes, and ships were carried there on their way round the Cape of Good Hope. Traffic from the Far East called on its journey round Cape Horn, and the South Atlantic whaling industry used the island as a supply base.

But, with the advent of steam, and the opening of the Suez and Panama Canals, shipping routes were profoundly changed, and Tristan became more and more isolated so that, by the beginning of this century, the visit of a ship was a notable occasion for the islanders. Yet by the middle 1920's the population had grown to 150, living an isolated, spartan existence, with very few natural resources.

In 1942 the island was again garrisoned by troops, from the Commonwealth and Royal Navy, this time to prevent possible occupation from marauding German submarines patrolling the Atlantic, and to set up a meteorological station.

After the war, the prosperity of the islanders increased by the introduction of a small fish-canning industry. This gave additional

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employment to the men in catching the crayfish abounding in the seas around, and to the women by working in the canning factory that had been built on the island. By late 1961 the population numbered 264, all bearing seven original surnames from the founders of the community.

PREVIOUS INVESTIGATIONS

Not unnaturally, these people have provided a very interesting social study for many years now, and a detailed account was published by Munch (1945). Amongst the various studies were several which first drew attention to their excellent dental health, including Marshall (1926), Sampson (1932), and Barnes (1937). Therefore, when the full-scale Norwegian scientific expedition went to Tristan in 1937–8 it included a dentist in its team. The survey lasted four months and resulted in a detailed account of the dental health of the islanders by Sognnaes (1954), and a report on their dental morphology and occlusion by Thomsen (1955).

Of the previous investigations quoted, relevant summaries by Marshall in 1926 gave a population of 140, but only one-third were examined. Very little was noted apart from their freedom from clinical caries, and the fact that very few children and only a small percentage of young adults showed traces of their coloured ancestry. Among the older population, though, this was marked.

Sampson, in 1932, recorded a population of 163 comprising 90 males and 73 females. He also remarked on their lack of clinical caries and healthy gingivae, speaking of a 'high' proportion with an edge-to-edge bite and one case of anterior open bite. Dummies were unknown, and there were no cases of thumb-sucking noted or admitted. Another feature observed was that every child was breast-fed, being weaned at 12–15 months.

This factor was also noted by other writers on primitive races, namely Campbell (1925) in his study of the Australian aboriginal dentition, and as recently as 1962 by Balogh and Huszar in Hungary. In their survey of 100 gipsies from 60 to 100 years of age presenting a high standard of dental health and low incidence of malocclusion, they noted, as two essential features, the absence of artificial feeding of infants among gipsies and the length of time spent in chewing food.

Sognnaes, in 1938, examined the total population of 188 Tristan islanders during his visit with the Norwegian expedition (Sognnaes, 1954).

Of their general health, there was no clinical evidence of endocrine disturbances, rickets, scurvy, tuberculosis, venereal disease, heart disease, joint disorders, or of renal and gastro-intestinal disturbances. Their main complaints were allergic in nature, manifesting as hay fever, asthma, migraine, and eczema. Physical deformities affecting the external ear, with deafness, and the extremities of the legs and arms were noted in three of the islanders. There were no cleft-palate cases. Mouth breathing was seen in 25 instances, being associated with increased adenoidal tissue in 14 and nasal polyp in 6. He recorded speech defects, judged by the pronouncing of 's', to be caused by abnormalities in position of tongue or teeth in 4 cases.

Munch, in his sociological observations at the same time, observed the high incidence of intermarriage amongst the islanders, stating that, of the 51 marriages on the island since 1875, 16 were cousin marriages.

Their staple diet was one of fish and potatoes for the greater part of the year with such seasonal additions as apples, seabirds and their eggs. Beef or mutton was a luxury, consumed only on the rare festive occasion from the few cattle on the island.

Of their dental health, Sognnaes observed their well-developed arches, satisfactory alinement, and good arch relationship, and also recorded their low caries incidence, supporting this with radiographic evidence. Clinical and X-ray examination showed slight attrition of the teeth by primitive standards, the oldest inhabitant, aged 80 years, having failed to wear through enamel. The biting force of the islanders was little above normal communities, and much below that, for example, of the Eskimo.

Inquiries regarding habits again showed no one who reported or admitted to thumb- or finger-sucking, and there was no biting of nails,

lips, or clothing. Toothbrushes were in the possession of a few of the islanders, but these were not used. Sognnaes also stated that the children were retarded in their dental development, only half the teeth having erupted within the age range considered normal by common standards. When the infants were cutting their first teeth, it was the custom on the island to give the child a bone to chew.

In addition to this, comprehensive dental examination casts were made of the islanders' occlusion from composition impressions, and from these models Thomsen's findings were published in 1955. These showed, in general, broad arches, with crowding occurring mainly in the lower incisor region, and increasing with age. Bimaxillary protrusion presented in a high proportion, a feature characteristic of Negro and Malayan species. Edge-to-edge incisal relationship was not observed in any of the islanders under the age of 25 years, and was more frequent in males than in females. Part of these findings we wish later to compare with some of our own.

After the war, however, further examinations by Wooley (1946) and Gamblen (1953) revealed a marked deterioration in their dental health. This was confirmed by King-Turner and Davies (1956) and Wallis (1958), who spoke of a dramatic increase in the prevalence of dental caries amongst the islanders of all ages.

Therefore, when volcanic eruption in October, 1961, necessitated the evacuation of the entire population to England, a unique opportunity was provided to ascertain their present dental health during the organization of a comprehensive dental service. This was done by a team headed by Slack and assisted by Holloway and James, and took place in January, 1962. At this time 255 of the refugee islanders were in temporary residence at Pendall Camp, Surrey.

METHOD

Four normal working days were set aside to conduct the entire examination, but owing to the death of the oldest islander this was reduced to three. The investigation was a full intra-oral one, using mirror and standard probe with good lighting conditions. This was augmented with bite-wing radiographs and intra-oral full-face and profile photographs in Kodachrome transparencies, using an electronic flash. In addition, an orthodontic assessment (Heffer and Lovius, 1962) was made of all

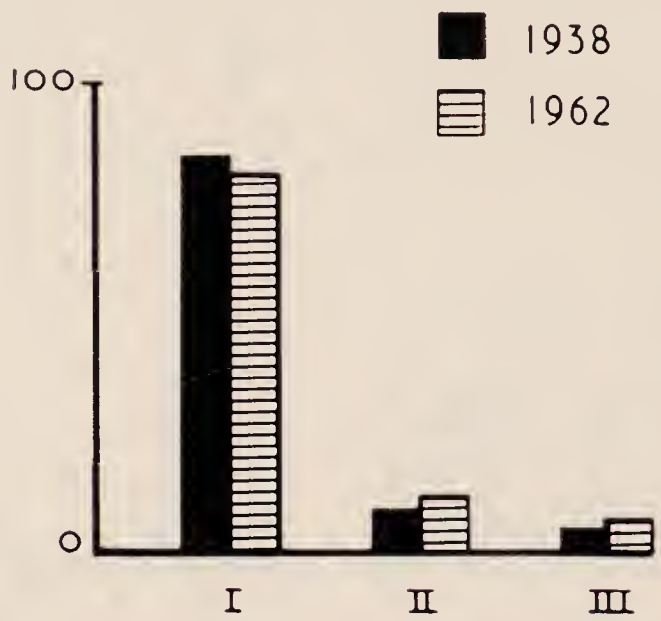

Fig. 1.—Comparison with Thomsen's figures for arch relationship using Angle's classification.

the islanders examined with alginate impressions, and incorporating for the first time on these people relevant soft-tissue patterns and skeletal classification that have become recognized as necessary in all such assessments. Our part of the investigation was conducted in the canteen adjoining the camp. Army portable field chairs were used, with one examiner doing the clinical examination, using a diagnostic sheet which could be filled in easily. To ensure consistency of results this was done by the one examiner. Impressions of their teeth were taken in Kromopan, an alginate material incorporating a colour-changing agent to reduce mixing and setting time to a fixed minimum. Hard wax squash bite recorded the occlusion for correct articulation of the models, and the impressions were cast immediately in quick-setting stone by the technician accompanying the team. One of the factors that was difficult to assess was the type of breathing, this being due to the very high incidence of colds among the islanders at the time.

RESULTS

Of the 264 islanders, 15 were ill, 13 were away working, and 7 declined to be examined. A further 21 were rejected as having too few

or too many missing teeth. This left 208, upon which number the survey is based. It is not proposed to give a mass of figures, but simply to give the breakdown of our findings as percentages. These will be compared and contrasted, where possible, with Thomsen and other similar studies. In general, we noted well-developed arches with good anteroposterior relationships, but loss of teeth in all age-groups where once were intact arches.

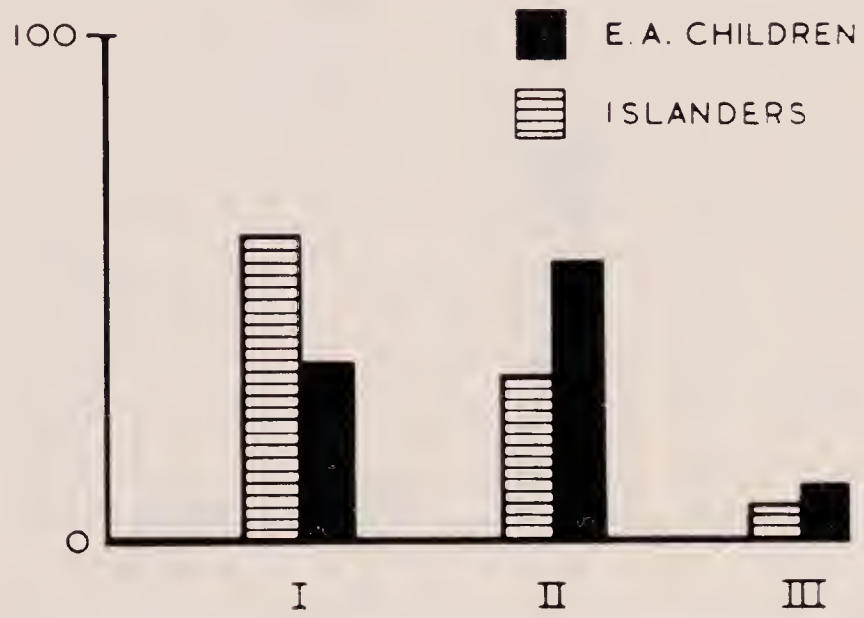

Fig. 2.—Skeletal base classification. Comparison with Walther's findings on East Anglian schoolchildren.

Using Angle's classification as a guide to our first figures (*Fig.* 1), we found them to be comparable with Thomsen, the majority of the islanders (81 per cent) having a normal arch relationship. Twelve per cent were postnormal and 7 per cent prenormal. Thomsen's figures from 113 models of islanders over 12 years of age were 85 per cent normal, 9 per cent postnormal, and 6 per cent prenormal. The skeletal base classification (*Fig.* 2) was also recorded, using the method of Ballard (1948). Here we found 60 per cent Skeletal I, 33·2 per cent Skeletal II, and 6·8 per cent Skeletal III. Comparing these figures with Walther's (1960) of 1000 East Anglian schoolchildren between 11 and 13 years of age, who found 35·6 per cent Skeletal I, 53·3 per cent Skeletal II, 11·1 per cent Skeletal III, we see that the islanders have a large percentage of Skeletal I; in fact, the figures for the Skeletal I and II's are almost reversed when comparing and contrasting the two groups, with a smaller percentage of Skeletal III's among the islanders. There were no extreme discrepancies in Skeletal II figures and only one in the Skeletal III figures.

We divided the skeletal groups on a sex basis (*Fig.* 3), and found, as can be seen here, a bigger percentage of female than male

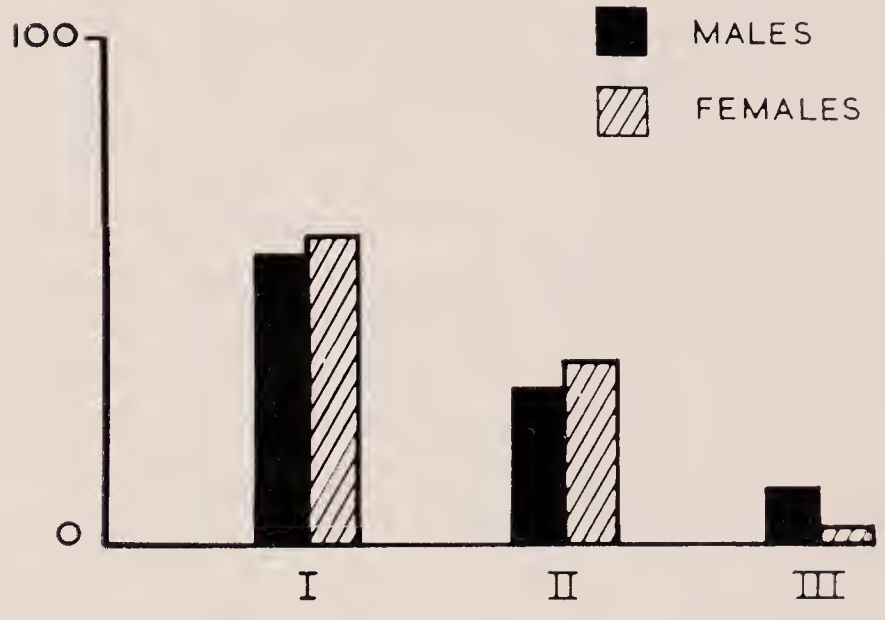

Fig. 3.—Skeletal group analysed on a sex basis.

Fig. 4.—Frankfurt-mandibular-plane angle.

Skeletal II's (35·5 per cent compared with 30·6 per cent), with this reversed in the Skeletal III's, which are predominantly male (11·2 per cent compared with 2·8 per cent). There is no great difference in the Skeletal I's (58·2 per cent male and 61·7 per cent female).

The Frankfurt-mandibular-plane angle (*Fig.* 4) was high in 53 per cent, normal in 37 per cent, and low in 9·0 per cent of the islanders, this factor contributing to the long-faced appearance of many. This also probably accounts for the relatively high number (17 per cent) with lower incisors which appeared clinically retroclined in relation to the mandibular plane.

On analysing tongue position in relation to Frankfurt-mandibular-plane angle, we found that approximately 45 per cent of the islanders have a normal tongue position, whilst among the remainder, a high tongue position appears

Table I.—Tongue Position in Relation to Frankfurt Mandible Age

FM Angle	Tongue Position		
	Normal	High	Low
High	45·3	24·5	30·2
Low	44·4	33·3	22·2
Normal	45·3	29·3	25·3

to be related to a low Frankfurt-mandibular-plane angle, and a low tongue position to a high Frankfurt-mandibular-plane angle (*Table I*). Tongue position was ascertained by

Table II.—Incisor Relationship

	Males	Females
Class I	51·0	41·9
Class II, division 1	12·2	12·7
Bimax. proclin.	3·1	14·5
Class II, division 2	2·0	4·5
Bimax. retroclin.	10·2	13·6
Class III	2·0	—
Postural III	2·0	—
Edge-to-edge	14·3	8·2
Other	1·0	2·9
Not recorded	2·0	3·6

noting the level of the upper surface of the tongue with the occlusal surface of the lower cheek teeth. When level it was normal; any noticeable difference above was recorded as high and below the occlusal surface as low.

For incisor relationship we subdivided the islanders into nine groups (*Table II*). It was seen that 51 per cent of the males are Class I, as compared with 41·9 per cent of the females. The females, however, show a greater percentage of Class II, division 2, bimaxillary retroclination, and bimaxillary proclination; the numbers with a Class II, division 1 labial segment relationship being about equal in the two groups. When we look at Class III, postural Class III, and edge-to-edge occlusions, we see a different picture. Here the trend is the other way, with a higher percentage of males showing these features. What is interesting is the relatively high proportion of islanders having a bimaxillary proclination. This type of malocclusion is relatively uncommon in Northern European groups, and is

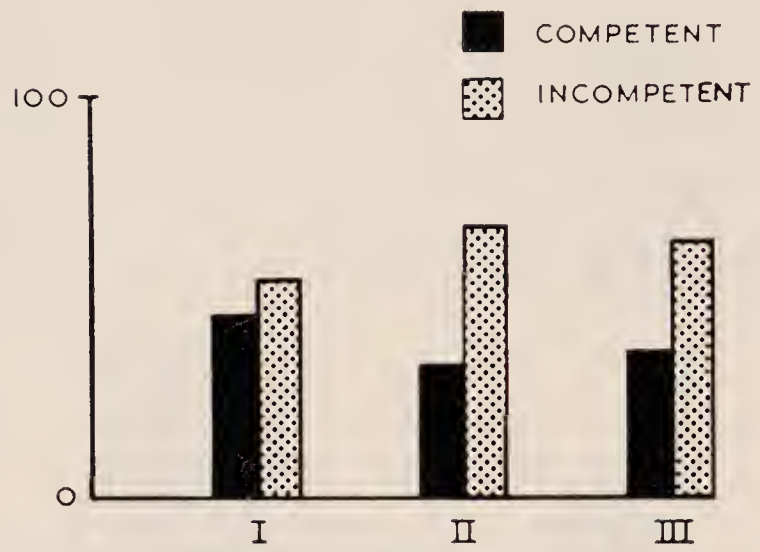

Fig. 5.—Lip competence and skeletal base.

probably resultant from the racial admixture, as negroid people show a high incidence of this. Of the islanders, 40·5 per cent have a normal overbite; 91·5 per cent have complete overbite; 51·5 per cent have a reduced overjet, the latter only being increased in 18 per cent and normal in 27·5 per cent.

The majority of the islanders have incompetent lips (*Fig.* 5) and this is seen in all skeletal groups, being most marked when

Table III.—Lip Competence and Skeletal Base

Skeletal	Lips	
	Competent (Per cent)	Incompetent (Per cent)
I	45·8	54·2
II	32·4	67·6
III	35·7	64·3

there is an anteroposterior basal discrepancy, that is, in those with a Skeletal II or Skeletal III dental base relationship (*Table III*).

Lip incompetence is found to a much greater extent in females than in males: 71·8 per cent in the former compared with 45·2 per cent in the latter.

When analysing the figures for lip competence, we found an interesting alteration in

relation to age (*Fig.* 6), for it was found that a linear relationship existed, apart from the 1–5-year-old group, who were more severely affected by the colds which were rife among the islanders when we saw them.

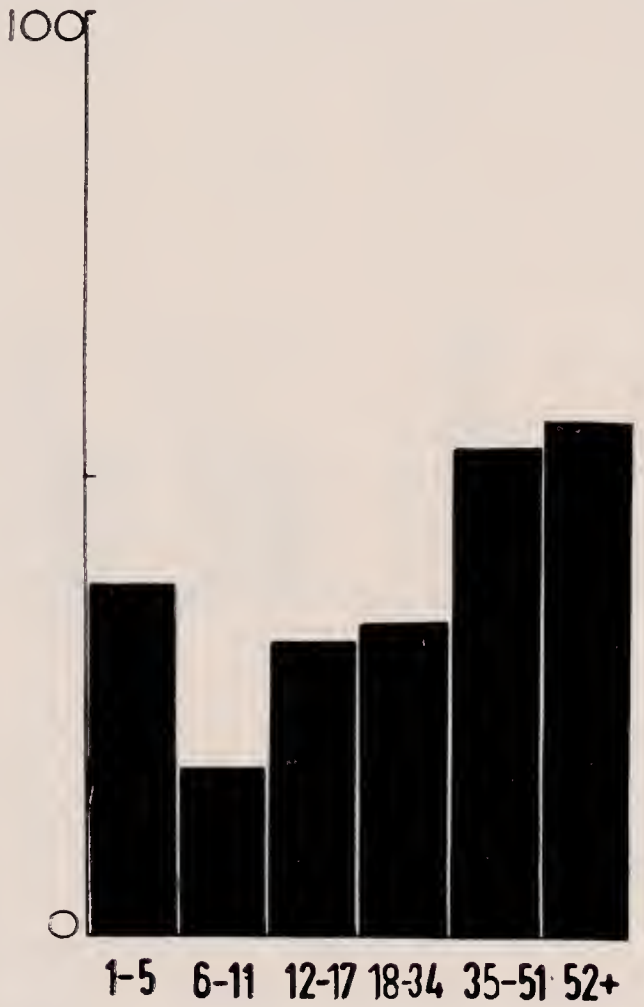

Fig. 6.—Lip competence and age-groups.

Thus, with increasing age, the lip morphology appears to alter, lip incompetence decreasing, competence increasing (*Table IV*).

On assessing lip behaviour in relation to age, we found, again apart from the 1–5-year-old group, an increase in the percentage of people whose lips were held habitually together, as compared with those whose lips were habitually apart. This is possibly related to the change in lip morphology, possibly as a maturation factor in the individual. The lip line, on the other hand, appears to move downwards with age, this being shown on an analysis of the figures in *Table V*, where it is seen that with increasing age there is a smaller percentage with a high lip line and a large percentage with a low lip line.

Table IV.—Lip Competence and Age-groups

Age in Years	*Competent (per cent)*
1–5	38·5
6–11	18·2
12–17	32·0
18–34	34·3
35–51	52·9
52+	56

Holloway, James, and Slack (1963), reporting on the caries incidence of the islanders, found that the teeth, with few notable exceptions, were grossly carious. In the older islanders it became increasingly difficult to decide whether missing teeth had been extracted because of caries or periodontal disease, and in view of this they recorded no observations on the caries incidence of islanders over 49 years of age. The women had a higher DMF rating than the men.

Table V.—Lip Line and Age-groups

Age in Years	Lip Line			
	Normal	High	Low	Not recorded
1–5	35·7	50·0	—	14·3
6–11	30·4	60·9	8·3	—
12–17	69·2	26·9	3·8	—
18–34	55·2	32·8	11·9	—
35–51	62·3	11·3	26·4	—
52+	24·0	—	72·0	4·0

There was an almost universal presence of periodontal disease amongst the adult population, and gingivitis and early periodontal disease were apparent even among the teenage group. They also found that the increase in the prevalence of dental caries reported in earlier studies has continued, the children being particularly affected, though in recent years the dental condition of the older age-groups has also worsened.

Table VI.—Labial Segment Crowding and Age-groups

Age in Years	Upper Labial Segment per cent	Lower Labial Segment per cent
6–11	45	52
12–17	42	57
18–34	54	67
35–51	57	86
52+	56	95

Although difficult to determine whether premature loss of deciduous teeth had occurred among the older groups, it certainly is

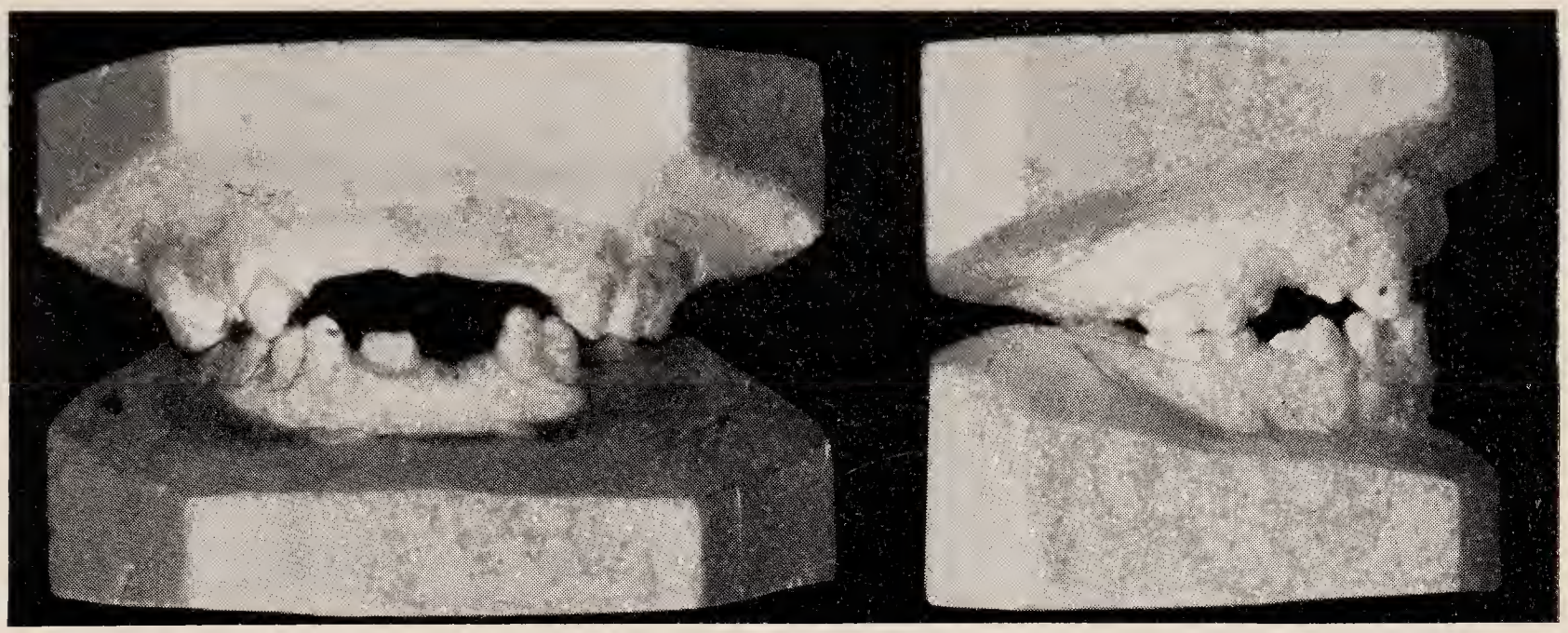

Fig. 7.—Early loss of deciduous teeth.

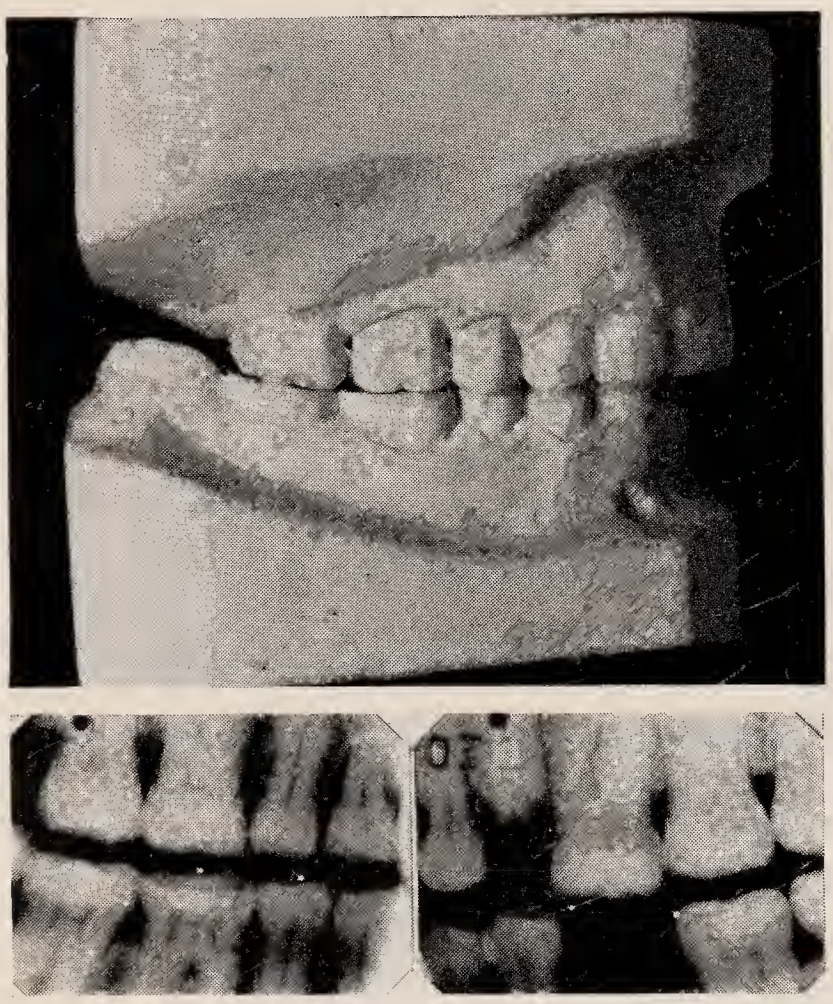

Fig. 8.—Marked attrition in a female aged 31 years.

occurring today, as can be seen from *Fig.* 7. We found it in 9·1 per cent of the islanders. One or more first permanent molars had been lost in 8·2 per cent, whilst 50 per cent showed evidence of loss of permanent teeth. Thirty-five per cent of the islanders showed signs of space loss, associatcd with early loss of deciduous or permanent teeth.

We thought it of interest to show an interesting example of marked attrition in a young woman aged 31 years (*Fig.* 8).

Crowding of the teeth was shown in all age-groups to be more severe in the lower

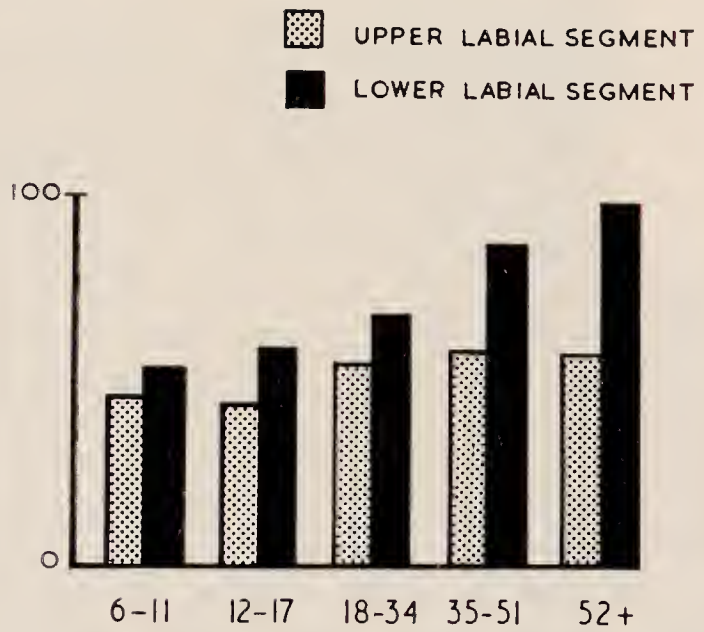

Fig. 9.—Labial segment crowding and age-groups.

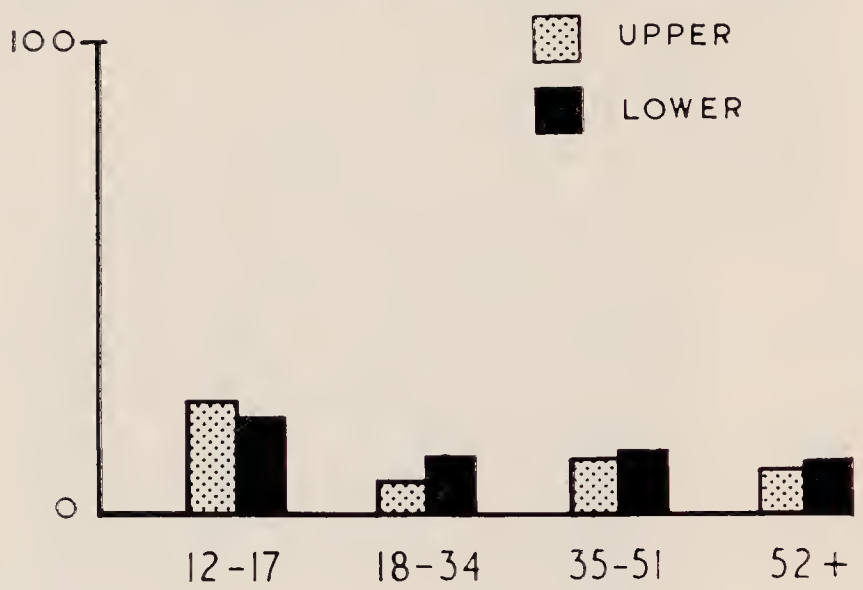

Fig. 10.—Buccal crowding and age-groups.

labial segment compared with the upper labial segment (*Fig.* 9). In fact there is marked increase of crowding with age in the lower incisors, going on beyond the age at which third molars reputedly have their greatest effect in causing disruption of previously well-alined arches. However, the

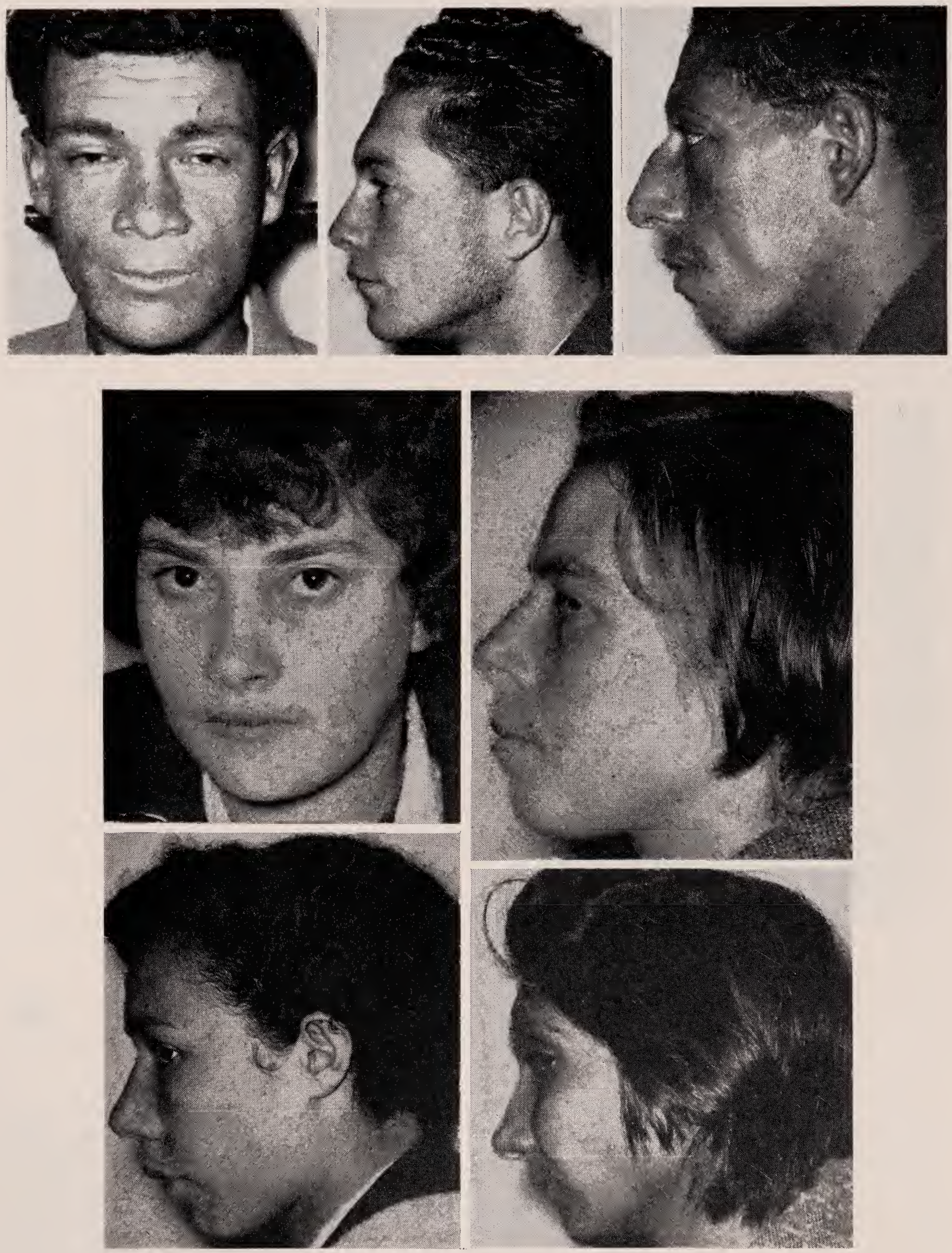

Fig. 11.—Examples of the islanders.

upper labial segments show remarkably little alteration in degree of crowding with age increase (*Table VI*).

Crowding in the buccal segments of either arch is relatively uncommon (*Fig.* 10), varying between 18 per cent in Skeletal I cases, 19·5 per cent in Skeletal II, and 31 per cent in Skeletal III cases. There is less crowding in the maxilla than in the mandible amongst the older groups, but a significant increase in crowding of both arches of the 6–18-year-old groups (*Table VII*). *Fig.* 11 shows examples of the islanders, and *Fig.* 12 shows typical occlusions.

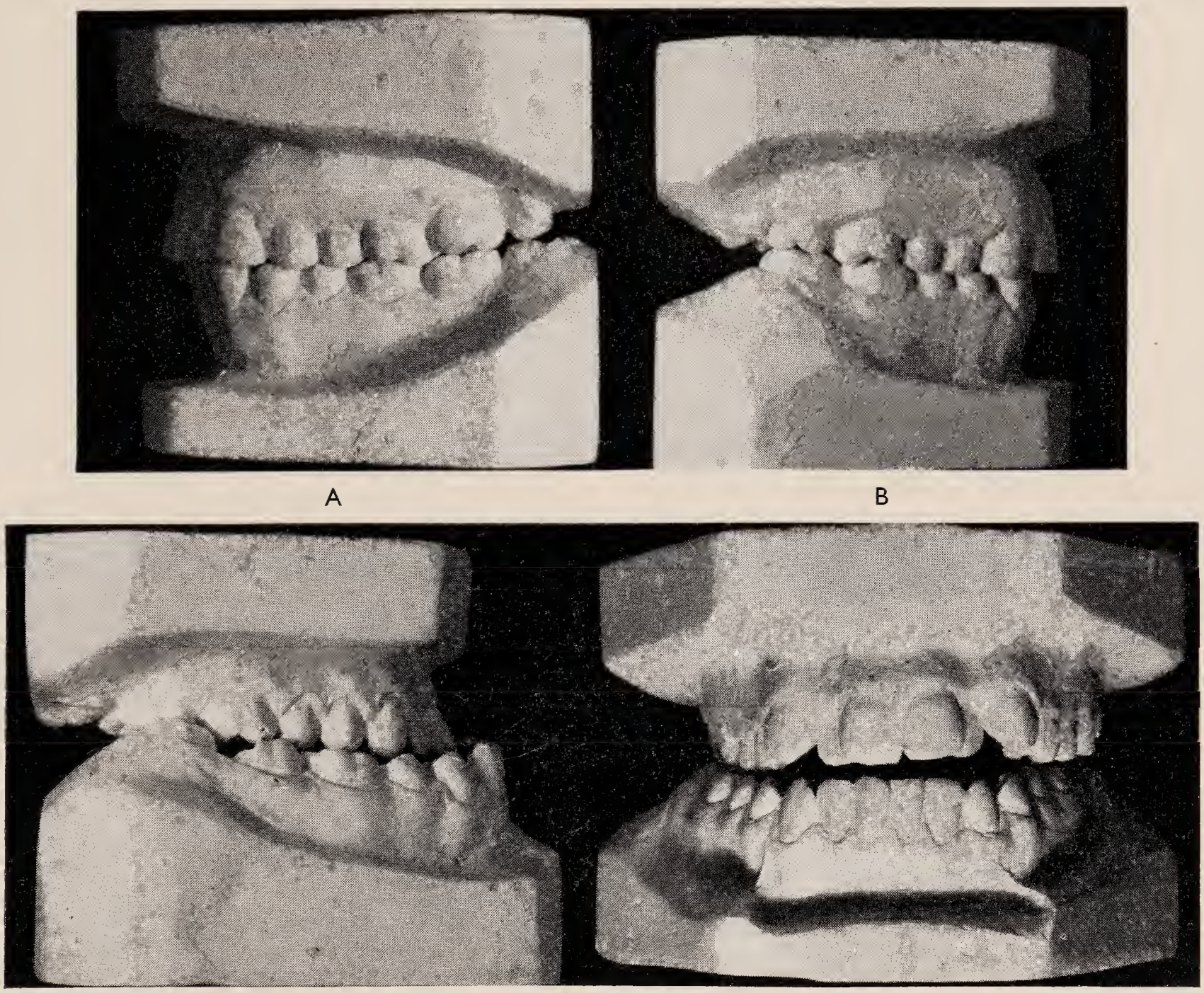

Fig. 12.—Examples of occlusions of the islanders. A, Bimaxillary proclination; B, Class I occlusion; C, Skeletal III, Class III malocclusion; D, Anterior open bite with crowding.

Table VII.—Buccal Segment Crowding and Age-groups

Age in Years	Upper Buccal Segment		Lower Buccal Segment	
	Right (per cent)	Left (per cent)	Right (per cent)	Left (per cent)
1–5	0	0	0	0
6–11	17·4	26·0	17·4	17·4
12–17	23·0	15·3	20·0	26·9
18–34	6·0	7·5	10·9	9·4
35–51	10·8	6·5	13·4	10·2
52+	9·6	5·0	10·6	10·6

SUMMARY

The islanders are found to have well-developed arches and a high proportion of satisfactory arch relationships. But evidence has been shown that this isolated primitive community once enjoying a very high standard of dental health has, in the relatively short

period of two decades, suffered a marked deterioration.

This points to changes in one of their environmental factors, contributing to a marked increase in caries incidence amongst Tristans of all ages. A change has been observed in malocclusion manifesting as an increase of crowding in the buccal segments among the younger generation suffering early loss. This was unknown among the islanders when earlier investigators made their observations before 1940. It is also noted that a change in lip morphology occurs, lip competence increasing with age.

THE FUTURE

With regard to the future of this community, an advance party returned to the island in the latter part of 1962. Their purpose was to ascertain whether Tristan was habitable again, and to see the condition of their former possessions. Reports were favourable and earlier this year nearly sixty of the older islanders set sail once more for their home. The majority, with exceptions amongst the young adults, hope to follow. Whether they will succeed in establishing their community once more remains a matter for conjecture. But they are a hardy people, trusting in God, and a study of their history shows that they have suffered misfortune before and have survived.

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DISCUSSION

Dr. R. B. Dockrell recalled that he happened to be working under Sognnaes at Harvard just after the War when he had the models to which the authors referred. He remembered spending at least one day looking at them, and that most of the crowded maxillae seemed to lie in one family; but that was a recollection of nearly twenty years ago.

He understood that the authors had been offered that these models would be sent over from America and he thought that it would have been very useful to compare these models of many of the islanders, when younger, or their parents, with the present findings. It was a wonderful chance to investigate the shift of anomalies and their inheritance. It was almost unique to have such a closed community, and the statistics were very interesting in such a case as the normal methods did not apply. For example, one did not need estimates about the population sample because one had the whole population; one did not need things like standard deviation when one could *show* the deviation. Surely statistics were mainly a grammar for displaying findings. Just as he could not speak to this meeting without following certain rules of grammar, in the same way it was necessary to use statistics when discussing a number of cases. Mr. James, yesterday, had showed incomparably well how statistics could be used to further the use and understanding of a paper. He would have liked to see more statistics used here so that there was some idea of the probabilities involved.

This work was of importance and was not, in all probability, repeatable; therefore he questioned the use of only one examiner. Although one examiner might ensure consistency of the findings within the group, it did not ensure that they were comparable with those of other workers, and surely that was the important issue here. Unless these authors were to cover all populations everywhere, they should be using agreed standards, and where no such standards existed, the ones used should be well defined in the text.

He was rather unhappy with the approach to incompetent lips. A 'linear relationship' was said to occur. How linear? Complete linearity was always an exception in biological studies, and a scatter diagram would have been very suitable for this material in many cases; in fact, for most cases, instead of these block diagrams, scatter diagrams would have been more useful.

He next wished to ask for more information about the assessment of crowding. It was most difficult to assess crowding accurately on models, as he knew to his cost.

There was, he felt, too little emphasis in this presentation on the separateness and uniqueness of these islanders. Much of what was said here could have equally well been said about East End schoolchildren. To him, the esscntial features of a presentation like this ought to

have been that they were Tristan da Cunhan Islanders, and more comparisons should have been made with other mixed and closed populations.

If he had been rather critical he hoped the authors would believe that this arose from the stimulation their work had offered, and from the belief that it was too valuable to be dismissed with mere platitudes.

Mr. W. Marsh said that the first point that struck him was that the diet of these Tristan da Cunhans was of the simplest and softest and most easily masticated food, and yet there was attrition occurring in those dentitions where there was a free and unrestricted lateral excursion of the mandible. This added considerable point to Professor Ballard's important observation that attrition of the teeth had very little connexion with roughness of the diet and did, in fact, occur only where the occlusion permitted unrestricted lateral excursions of the mandible. The point had arisen previously in a communication to the *British Dental Journal*, which deseribed how a group of Ukrainians were examined for attrition of the teeth and it was found that they, on the same diet as a group of Western Europeans, had a good excursion of the mandible and good attrition.

One would expect not to find, in a primitive community, severe malocclusions of the teeth, or cleft palates. One would expect such malocclusions to be lethal to their owners and not to be transmitted.

With regard to the connexion of incompetent lips with age, that probably was due to the fact that with increasing age there was increasing loss of teeth which would lead to decrease of lip competence.

Mr. R. Belcher said that he had been concerned in the actual treatment of these Tristan da Cunhans. One thing not mentioned was the coloration of the teeth. What were the authors' views on this?

There had been a reference to attrition. This was found to be extraordinarily marked. The only other instance of a similar degree of attrition known to him was in an Italian prisoner-of-war camp. But there again their diet had been very different from that of the Tristan da Cunhans. He could understand why the Italians had that terrific attrition, but certainly the Tristan da Cunhans did not live on the harder forms of diet.

Mr. G. C. Dickson said that he had always understood that attrition was not due to the hardness of the diet but to the dirt eaten with it.

Dr. J. R. E. Mills asked how the speakers assessed the incompetence of the lips. It was normally found that children in their teens went around with their lips apart, whereas adults went around with them together. It was difficult to assess the competence or otherwise of lips when they were together. It was very subjective.

Mr. I. F. Davidson asked if the speaker would give the actual figures for the Frankfurt-mandibular-plane angles; he merely said 'abnormally high' and 'abnormally low'.

Mr. P. T. Heffer (in reply) said that Dr. Dockrell implied that the authors had rejected the offer of models. They had not. The authors hoped to make a comparison when they were able to get them at a later date.

It was extremely interesting to find someone like Mr. Belcher who had met and treated the Tristans. He did not feel that he could make observations about tooth coloration, as all his very limited time had been spent taking impressions.

Most of their findings were from observations of the models. He did not know whether Mr. Lovius had observed the clinical aspect of them. There would be a paper published later by Holloway, Slack, and James that might have something to say on this.

With regard to Mr. Diekson's remarks, he was unable to say anything about dirt in the diet. Sognnaes had made the observation in his findings on the islanders that an 80-year-old had no attrition at all. Mr. Heffer said that he imagined after 80 years of age one was bound to have eaten a bit of dirt!

Mr. B. B. J. Lovius (in reply) thanked Dr. Doekrell for his kind remarks. What the authors had done was only part of the work; there was too much to present at one time. They had made observations on the wear of the teeth, but these had not been presented yet.

Crowding of the teeth was mentioned. Thomsen's method was used, whose work had been followed to some extent; less than half the width of an incisor was assessed as mild crowding, half to one incisor as moderate, and more than an incisor as severe. They had gone into the severity or degree of crowding, but had not presented their findings yet.

With regard to Dr. Mills's point, in the assessing of lip incompetence they had used the criteria as described by Professor Ballard; they had also noted whether the lips were habitually together, apart, or variable.

With regard to Mr. Davidson, concerning figures for Frankfurt-mandibular-plane angle; again this was, as had been said, a very rapid survey, and there was not time to measure with a protractor. This was a clinical assessment of whether the Frankfurt-mandibular-plane angle appeared high, normal, or low. The average was about 28° on a clinical assessment.

RAPID MAXILLARY EXPANSION

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DURING the last ten years there has been an increasing interest in rapid expansion of the maxilla, notably by Derichsweiler (1953) and Krebs (1959) in Europe and by Haas (1961) in the United States. Animal experiments to confirm the clinical radiographic appearance of a split in the bone and its subsequent repair have been carried out by Derichsweiler (1957), Debbane (1958), and Haas (1959).

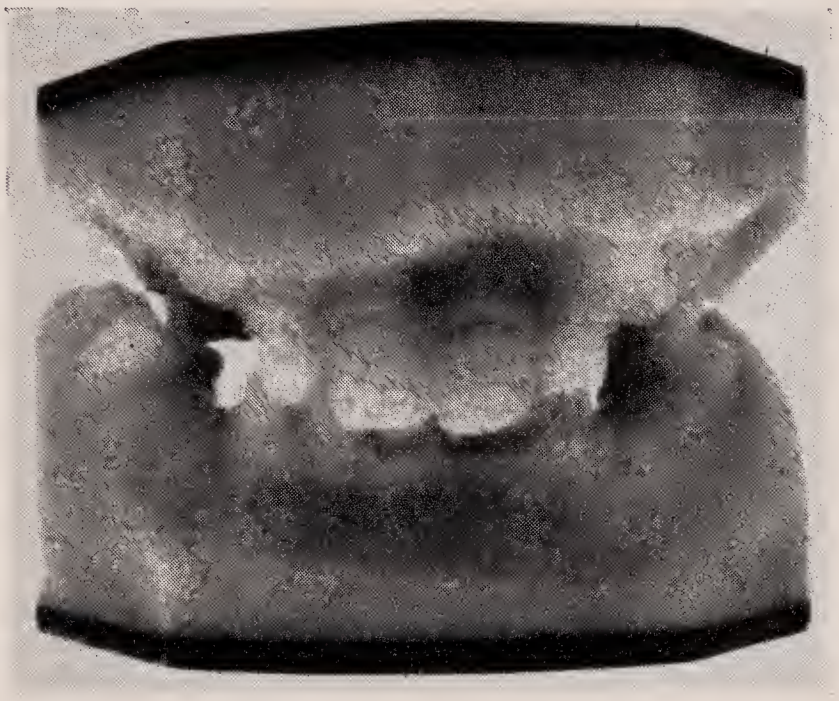

Fig. 1.—Unilateral cross-bite on the right side, prior to expansion.

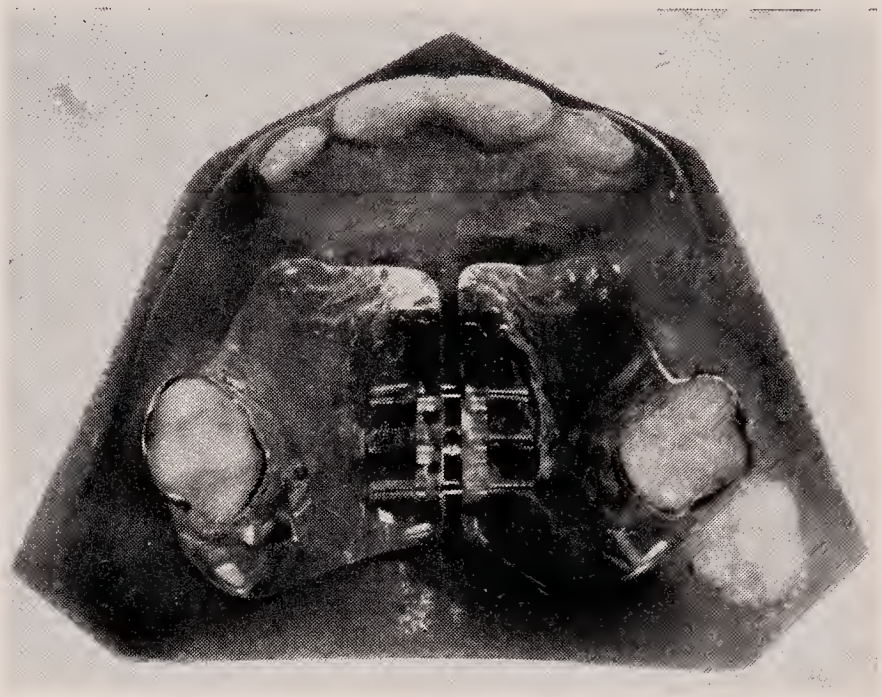

Fig. 2.—Expansion appliance attached to the first permanent molars, with midline expansion screw.

More recently Chatellier and Chateau (1963) have suggested ultra-rapid expansion. They consider this is most suitable up to 9 years of age, of some value up to 12 years of age, but definitely contra-indicated after 16 years, when the 'classical' rapid expansion is more appropriate.

It has been suggested that acute maxillary expansion produces first a widening of the apical base with a reduction of crowding and elimination of cross-bites, and secondly enlarged nasal air-passages with improvement of nasal respiration. The technique was used in Liverpool, primarily for orthodontic reasons: First, where there was slight crowding combined with cross-bite and loss of one or two units would leave excessive spacing. Secondly, where there was lateral displacement of the mandible due to occlusal interference, caused either by unilateral or bilateral cross-bites (*Fig.* 1).

The procedure adopted is as follows: At the first visit bands are constructed for the first premolars and first molars. Where the premolars are unerupted, bands on the two molars may suffice, but the risk of the appliance loosening is considerably increased. A composition impression is taken and cast in stone with the bands in situ and tags are then welded on to the bands to assist attachment of the acrylic base which is made in the form of a saddle. This incorporates a midline expansion screw (*Fig.* 2), so placed that the key opens the screw by turning from the incisors backwards. The most satisfactory screw has been found to be the Fischer 777 made by Hawley-Russell.

At the next visit the appliance is cemented into place and a quarter-hour allowed for the cement to harden. At this stage it is important to have the active co-operation of a

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A Demonstration presented at the Country Meeting held at Norwich on 17 May, 1963.

parent, as it has been found impossible for most children to turn the screw each day by themselves. One quarter-turn is given by the operator, by way of demonstration, and then at 5-minute intervals 3 further quarter-turns are given by the parent, under instruction. At the end of this time they are usually sufficiently competent to continue giving 2 quarter-turns per day until a total of 37 is reached. The expansion is then 7·4 mm., taking a little more than two weeks to complete.

If this does not produce adequate expansion it is better to make a new appliance, rather than continue opening the screw. Otherwise there may be distortion of the appliance with a break in the cement seal securing the bands. Towards the end of the treatment period a marked central diastema appears (*Fig.* 3). The patient should always be warned of this development and the fact that it is self-correcting within two or three months.

Fig. 3.—Immediately after expansion, showing the elimination of the cross-bite and the marked central diastema.

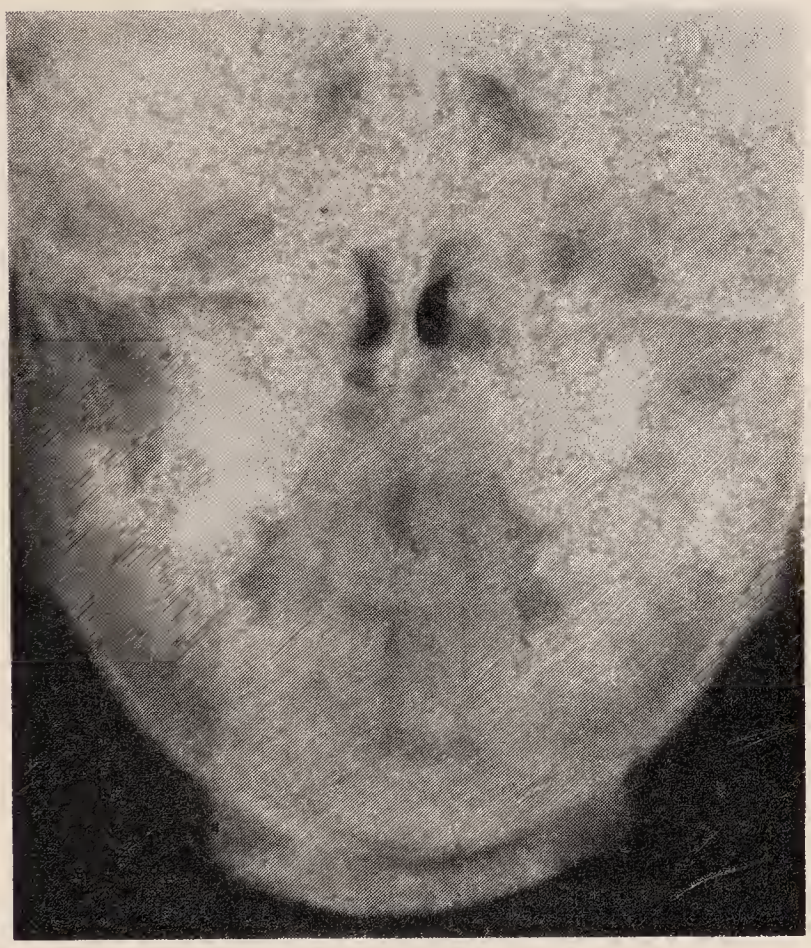

Fig. 4.—Anteroposterior cephalogram prior to expansion.

Fig. 5.—Anteroposterior cephalogram immediately after expansion, showing the marked separation of the apices, as well as the crowns, of the central incisors.

After the period of active treatment is completed, the appliance is allowed to remain in place for a further month, prior to the fitting of a removable saddle retainer incorporating Adams' cribs. This is worn full-time for a period of six months. Twelve patients have been treated using this technique and at no time have any complained of pain, and, except in a few isolated cases of hyperaemia, the mucous membrane is in good condition when the fixed appliance is removed after six weeks. The anteroposterior cephalograms of the patient demonstrated show the condition before expansion began (*Fig.* 4) and immediately after completion (*Fig.* 5).

Acknowledgements.—I would like to thank my colleagues at the Liverpool and Edinburgh Dental Hospitals for the help they have given to me, and particularly Mr. S. Bailie, of the Photographic Department, the University of Liverpool, for his preparation of the demonstration.

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FUNCTIONAL RETENTION

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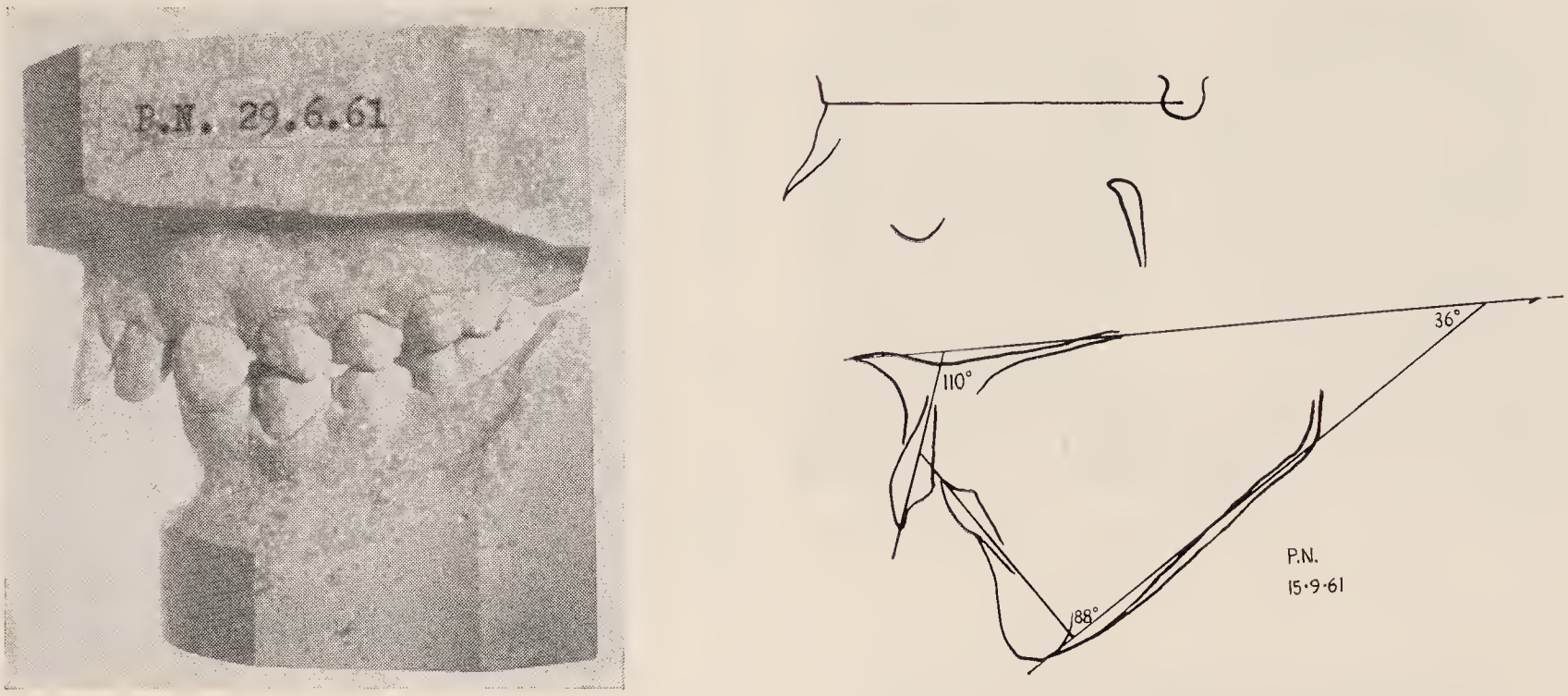
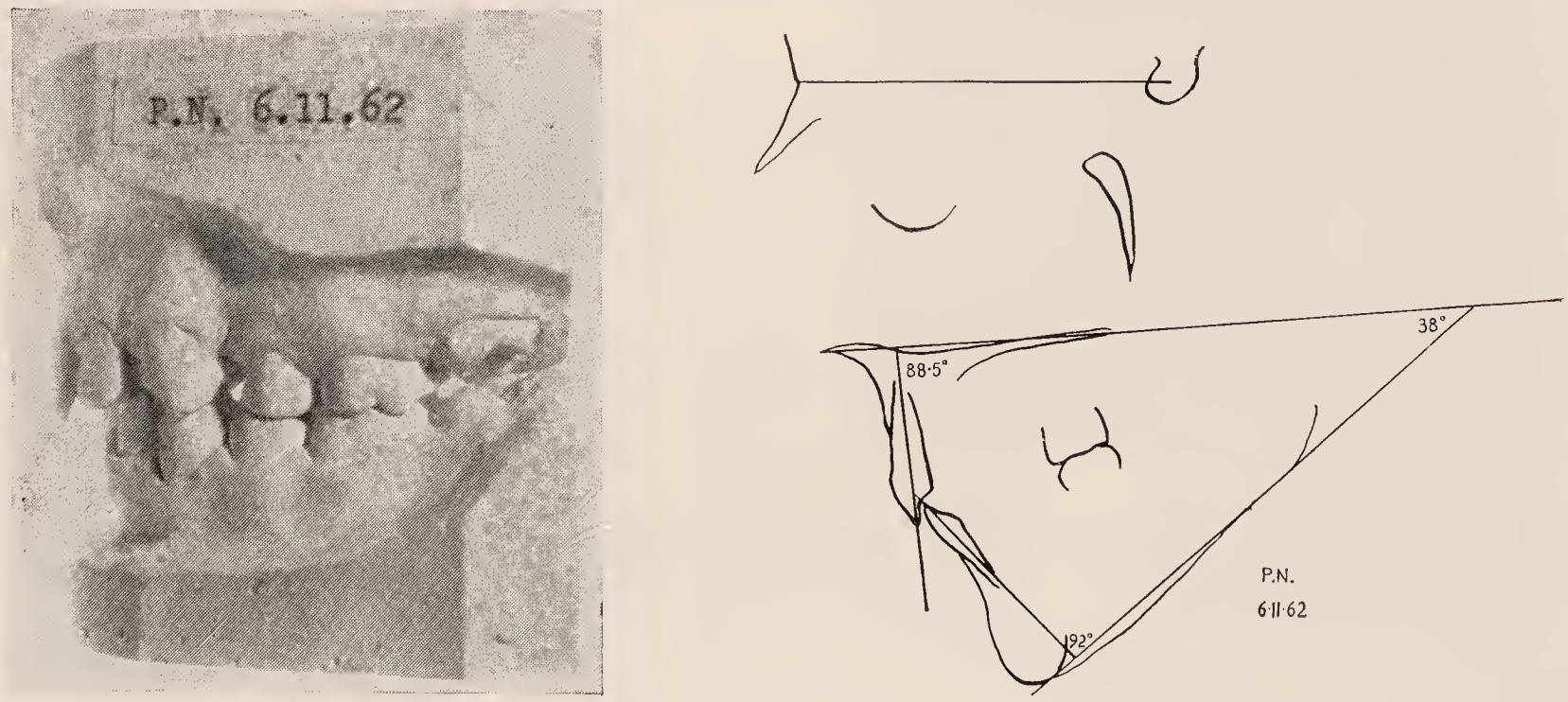
RETAINING appliances, fixed or removable, aim to stabilize teeth against soft tissue, and occlusal forces, during the period when many inequities of occlusion produced during treatment are retained. Further tooth movement may occur following withdrawal of the



A B

Fig. 1.—*Case* 1. A, Record models to show occlusion at commencement of treatment. B, Tracing of lateral skull radiograph to show incisor relation and dental base relationship at commencement of treatment.



A B

Fig. 2.—*Case* 1. A, Record models to show occlusion at conclusion of treatment. B, Tracing of lateral skull radiograph to show incisor relation at conclusion of treatment.

reorganization of the periodontal tissues is taking place. Removable retainers allow teeth to change their vertical relationships, but retaining appliance, and this may be referred to as either settling of the occlusion, or relapse, depending on the degree of movement.

A Demonstration presented at the Country Meeting held at Norwich on 17 May, 1963.

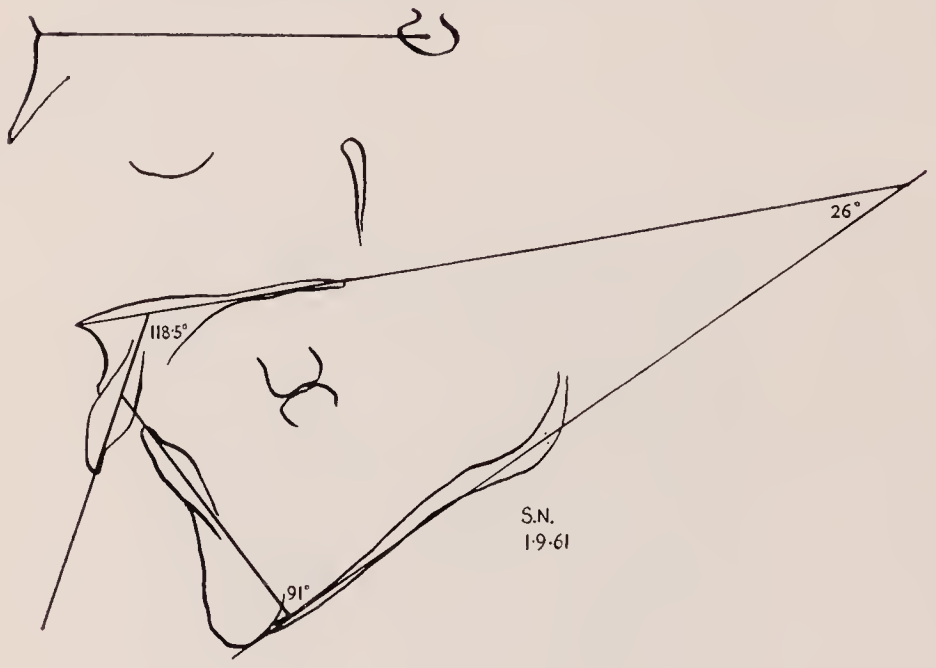
When teeth are moved to a position of occlusal and soft-tissue balance, retaining appliances can be shown to be unnecessary.

CASE REPORTS

Case 1.—The first patient, P. N., aged 12 years, was first seen in July, 1961, and the following notes were made.

Fig. 3.—*Case* 1. Lower lip labial to labial segments whilst at rest and during activity.

A



B

Fig. 4.—*Case* 2. A, Record models to show occlusion at commencement of treatment. B, Tracing of lateral skull radiograph to show incisor relation and dental base relationship at commencement of treatment.

'The patient has a satisfactory standard of oral hygiene and the gingival condition is good. All permanent teeth are present, $\frac{87|78}{87|78}$ being unerupted. There is a Class II, division 1 type of incisor relationship (*Fig.* 1 A), the upper labial segment being proclined relative to maxillary plane (*Fig.* 1 B). During mandibular closure there is a deviation to the right due to initial contact in the buccal segments, producing a cross-bite on $\frac{6|}{6|}$.

'There is a postnormal dental base relationship which contributes to produce the increased overjet. The lips are incompetent, and at rest the tongue is postured to contact the lower lip. A tooth-apart swallow with tongue thrust accompanied by contraction of lower lip can be observed. The speech is clear and no history of sucking habits can be obtained.'

TREATMENT.—Treatment was aimed at reduction of the anterior overjet. This was achieved, using upper removable appliances, from September, 1961, until November, 1962, $\underline{4|4}$ having been extracted. A satisfactory incisor relationship had been established in November, 1962, and the appliances were withdrawn (*Fig.* 2).

The soft-tissue pattern was similar to that noted at the commencement of the treatment, there being one salient difference in that, prior to treatment, contraction of the lower lip musculature took place between the labial segments, whereas lower lip activity now takes place buccal to both labial segments (*Fig.* 3). The continued stability of the new incisor relation without the need for retaining appliances may be attributed to this alteration.

Case 2.—The second patient, S. N., was first examined in June, 1961, and at that time was 12 years 11 months old. The following entries were made in the case history.

'The standard of oral hygiene and gingival condition is good. Radiographs show that $\frac{8|8}{8|8}$ are absent, $\overline{|5}$ being unerupted. The remaining permanent teeth are present in the mouth. There is a Class II, division 1 type of incisor relation present (*Fig.* 4 A), the upper labial segment being proclined relative to maxillary plane (*Fig.* 4 B). $\underline{5|}$ is rotated through 90°. There is a postnormal dental base relationship. Spaces are present between several teeth indicating dental bases of adequate extent. The lips are incompetent. The teeth are together and there is marked contraction of lower lip musculature during swallowing.'

TREATMENT.—Treatment was aimed at opening space for $\overline{5|}$, and rotation of $\underline{5|}$, followed by reduction of the overjet. Extraction of teeth was not considered necessary.

Fixed and removable appliances were in place from July, 1961, until August, 1962, during which time the

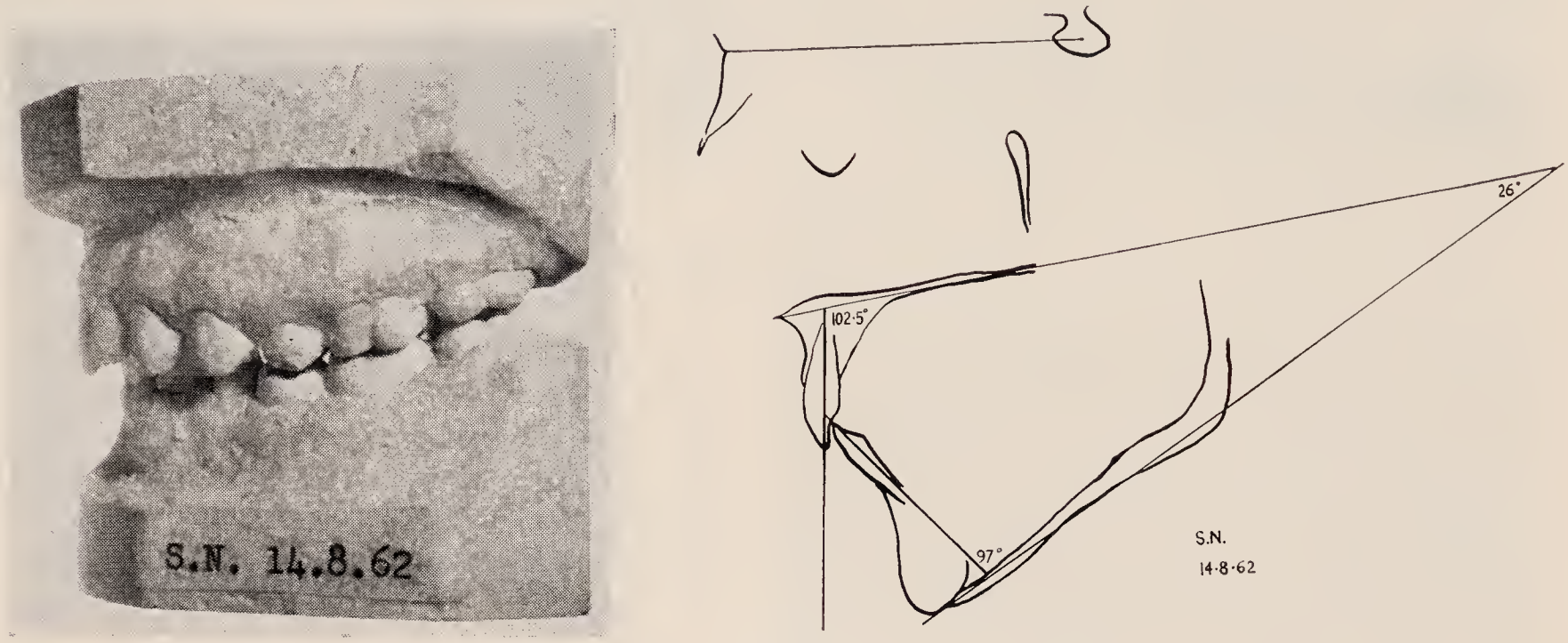
overjet was reduced (*Fig.* 5). The incisor relation has remained stable without the use of appliances for retention.

Case 3.—The third patient, M. L., was first examined in May, 1961, when she was 11 years of age; unfortunately cephalometric records were not obtained. The following notes were made in the case history.

'The gingival condition and standard of oral hygiene are high, caries being controlled. Radiographic examination shows $\underline{8|8}$ to be absent and $\frac{75|7}{87|78}$ unerupted. The contraction of the lower lip muscles. A strap-like action of the lower lip against the lower incisors is observed during expressive behaviour.'

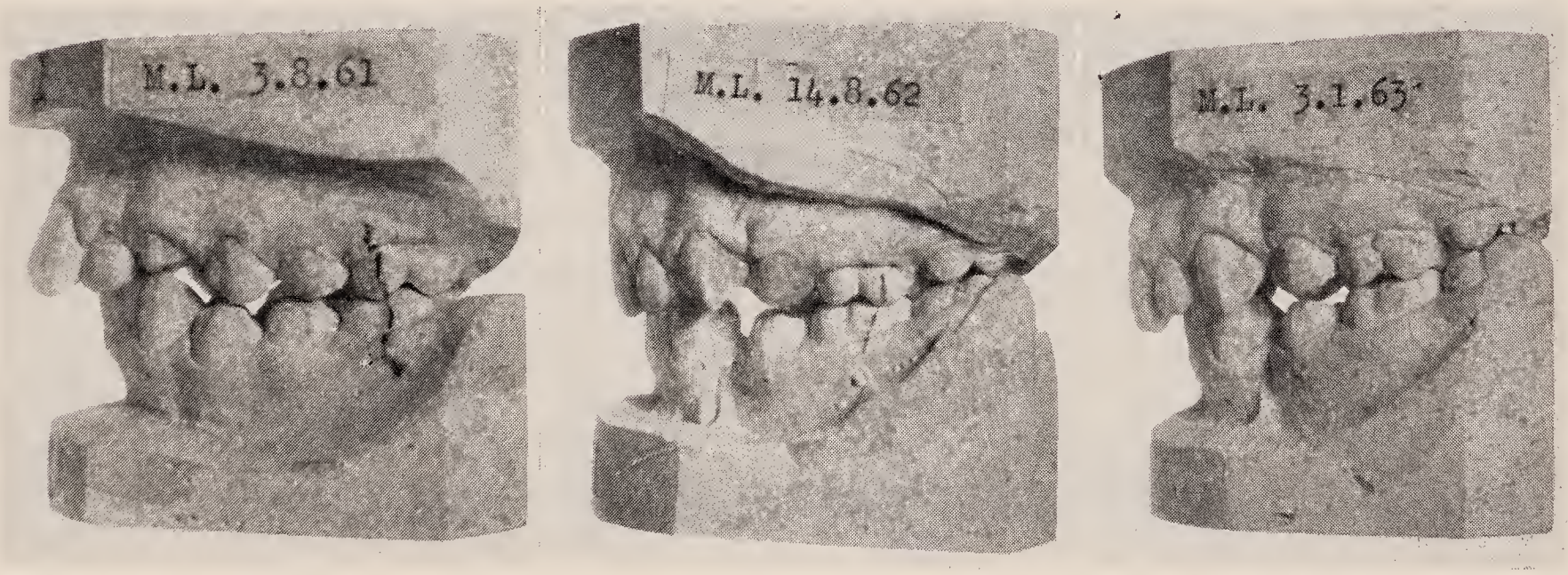
TREATMENT.—Treatment was aimed at elimination of crowding which was present in both upper and lower arches, together with reduction of the overjet.

This was achieved between September, 1961, and August, 1962, using upper removable and lower fixed appliances, $\frac{4|4}{4|4}$ having been extracted (*Fig.* 6 B). Retaining appliances were not used. When record models



A B

Fig. 5.—*Case* 2. A, Record models to show occlusion at conclusion of treatment. B, Tracing of lateral skull radiograph to show incisor relation at conclusion of treatment.



A B C

Fig. 6.—*Case* 3. A, Record models to show occlusion at commencement of treatment. B, Record models to show occlusion at conclusion of treatment. C, Record models showing occlusion five months after appliances had been withdrawn.

remaining permanent teeth are present in the mouth. A Class II, division 1 type of incisor relation is present (*Fig.* 6 A), the upper labial segment being proclined relative to the maxillary plane. There is a postnormal dental base relationship. The lips are incompetent and during swallowing the teeth are together, there being

taken five months after withdrawal of appliances (*Fig.* 6 C) are compared with those taken at the conclusion of treatment (*Fig.* 6 B) a slight relapse of the incisor relation will be noticed. This occurred immediately following removal of appliances and is not progressive. The photographs (*Fig.* 7) endorse the opinion that

Fig. 7.—*Case* 3. A, Lips at rest at conclusion of treatment. B, Position of lower lip at rest. C, D, Lip position during swallowing.

during activity, and at rest, the lower lip is now retaining the position of the labial segments, as there has been no alteration of soft-tissue pattern as a result of treatment; the only alteration being that when the lower lip contracts it now does so buccal to the labial segments.

The experience gained during thc treatment and follow-up of these patients leads one to conclude that, providing the incisal segments are repositioned to lie within soft-tissue balance, mechanical retention is not required. This does not apply following treatment of rotated teeth or cases where anterior diastemata are closed during treatment.

In cases where prolonged retention has been prescribed the action of the soft tissues and consequent relapse are merely being postponed. The stability of the result depends on correct pretreatment analysis and success of the mechanical method.

Acknowledgements.—The author wishes to express thanks to Mr. J. S. Baillie and technical staff of the Photographic Department, Liverpool Dental Hospital, for help with the illustrations.

THE LOWER LIP AND THE UPPER INCISOR TEETH IN ANGLE'S CLASS II, DIVISION 2 MALOCCLUSION

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The University of Bristol Dental Hospital and School

When one has had the opportunity to read the paper which Miss Ridley presented before this Society (Ridley, 1961) it becomes apparent that an investigation of Angle's Class II, division 2 malocclusion along similar lines could possibly equal, but not surpass it, in excellence and scope. It does, however, provide an admirable starting-point for this short paper which has a distinctly limited scope. It is intended to examine further two features that are commonly associated with this malocclusion.

In Miss Ridley's paper the relationship of the lip line was judged clinically to be high in almost all the cases. This feature appeared to be one of the less variable ones. It is a subject previously investigated by me, measurement of lip coverage of the upper incisors being made in normal occlusion (Nicol, 1955). It was thought profitable to submit a group of Class II, division 2 malocclusions to a similar investigation and compare results. A sample of twenty Class II, division 2 malocclusions was therefore measured by the same technique as that already reported. This yielded a mean value for the height of lip line above the incisal margins of the upper central incisors of 6·0 mm. with a standard deviation of 1·1 mm. The mean value for the group of 27 normal occlusions was 4·8 mm., with a standard deviation of 1·2 mm. To compare the mean values of the two groups a '*t*' test produced a value for '*t*' of 3·5, which is highly significant. This suggests that in Class II, division 2 malocclusion there is control of the upper incisors by an increased depth of lower lip.

If we look at a particular case where the upper lateral incisor on one side has escaped the control of the lower lip but is controlled by it on the other side, we see the great difference not only in axial inclination but in height relative to the occlusal plane (*Fig.* 1). Parker (1963) recently published a paper dealing with this matter of occlusal height of the dento-alveolar structures, comparing a random sample with Class II, division 1 malocclusions.

Fig. 1.—The lower lip is controlling $\underline{|2}$, but not $\underline{2|}$. There is a considerable difference in the occlusal height and axial inclination of these teeth.

His work lends support to this view of muscle influences in the incisor region bringing about a variation in occlusal height.

Another feature which must be taken into account is the slope of the inner surface of the lower lip in relation to the axial inclination of the upper incisors. The slope of the inner surface is reflected to some degree in the contour of the outer surface of the lip. It is this outer surface that Sarnäs (1959) investigated in his monograph on facial profile, and referred to it as the depth of lower lip curvature. He concluded that although there were exceptions, an everted type of lower lip tended to be associated with an increase in overbite of the incisors. The point that can be made about this type of lip shape is that the slope of the inner surface in relation to the axis of the upper incisor will determine to some extent how much the incisor will tilt lingually

Part of a Symposium presented at the Country Meeting held at Norwich on 18 May, 1963.

if it develops further vertically relative to the lip (*Fig.* 2).

Thus, in treatment, the upper incisor can, I believe, be moved labially, provided that it is also moved upwards, so that the labial surface of the incisal margin moves upward and outward following the slope of the inner surface of the lower lip. The anterior boundary of the neutral zone is not flat (*Fig.* 3); if it were, I would agree with Hovell (1962) that in treatment all that can be hoped for is the lingual movement of the root apices. In any case, an upward movement is desirable if the deep overbite is to be reduced. Furthermore, a labial and upward tilt of the upper incisor is quite likely to produce a lingual movement of the root apex.

The morphology of the upper incisors themselves is worthy of some consideration. At various times in the past the view has been expressed that if the crown of the incisor is angled lingually to the root, a deep overbite is likely to be present and the prognosis in such cases is poor. Ridley (1961) dismissed this feature with the comment that it was being investigated by others. I hope those engaged in this work will forgive me if I poach on their preserve.

This project was started with the object of probing the difficulties involved in the investigation rather than producing results. However, the results did turn out to be of a consistency which was not expected and as such are worth reporting.

A group of 12 Angle's Class II, division 1 malocclusions and a group of 12 Angle's Class II, division 2 malocclusions were compared. The cases were selected for the clarity of the X-ray image of the upper central incisors on cephalometric X-ray films. These films were put in a photographic enlarger to increase the image by 8 diameters and an outline drawing of one upper incisor was made. The axes of crown and root were obtained by halving the angles produced by lines from the anatomical neck to the midpoint of the incisal edge and apex of root. When the root apex lay lingual to the crown axis the angle between crown and root axis was called a 'positive angle' and where the root apex lay labial, a 'negative angle' (*Fig.* 4).

Table I shows that although there is some overlapping, all the high positive angles belong to the division 2 group, and all the high negative angles to division 1. The upper central incisors in Class II, division 2 malocclusion therefore tend to have their crowns tilted lingually in relation to the roots compared with the incisors of division 1 malocclusions. Before more can be said on this subject more investigation is required. The upper central incisor frequently erupts at a

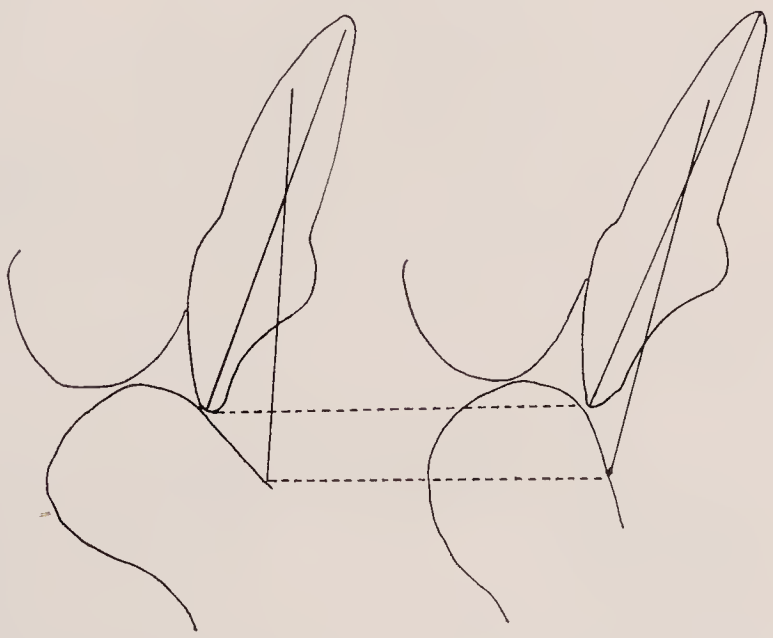

Fig. 2.—Drawing to show how the axial inclination of an upper incisor will be influenced by the slope of the inner surface of the lower lip if it develops farther occlusally. On the left, with the everted type of lower lip, the incisor will be tilted farther lingually.

Fig. 3.—The higher of the incisor outlines shows the position to be aimed at in the treatment of Class II, division 2 malocclusion.

stage of development when only about half of the root is formed. Could a muscular environment tilting the crown lingually bend a tooth so as to produce this root-to-crown angulation? Or is it a tooth form which is entirely endogenous? If further investigation into what other features are present in the cases with high positive angles is undertaken, it may give some indication of the aetiology of this tooth form.

It would be interesting to find out if the slope of the inner surface of the lower lip bears any relationship to the skeletal pattern. One would expect there to be one, attachment of the muscles being farther back in a Class II skeletal pattern. Indeed, in presenting this short paper I am aware of the fact that many of the views expressed require integrating with all of the complex that makes up the malocclusion we call Angle's Class II, division 2.

Table I.—Root/Crown Angles

Class II, division 2	*Class II, division* 1
14	
13	
12	
10	
8	
8	
8	
7	
6	
	5
2	2
2	2
	1
	1
	0
2	2
	2
	4
	5
	5
	8

Values are in degrees. Those above the horizontal line are positive and those below negative.

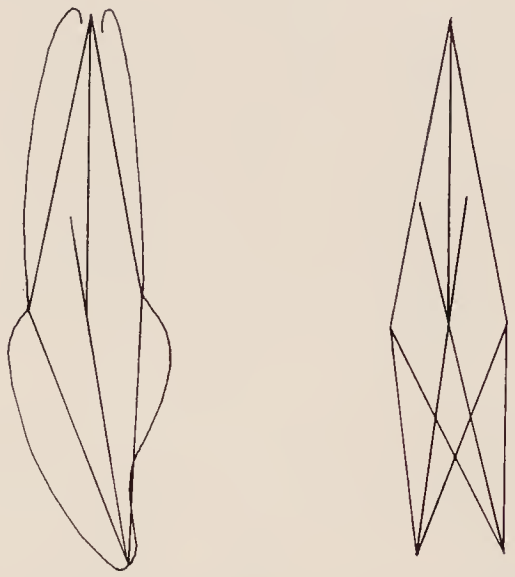

Fig. 4.—The drawing on the left illustrates the method used in determining the crown and root axes, and the angle between them. On the right is a composite drawing of the greatest positive and negative angles in the group examined.

Acknowledgements.—I am indebted to Dr. M. V. Stack for the statistical part of this paper and to the University of Bristol Medical Photographic Department for the illustrations.

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DISCUSSION

Dr. W. J. Tulley said it was not possible to lump all Class II, division 2 cases into one common group.

Mr. Nicol's paper tackled two very salient points, one of them being the morphology of the lips, and the other the morphology of the incisors. It was necessary to break down this complex to study it, but when they came to look at it clinically they realized that it was a complex.

He wished now to retract a statement he made in discussion, in 1955, on Mr. Nicol's original paper, to the effect that he thought function was more important than morphology. He would now entirely agree with Mr. Nicol that probably the morphology factor triggered off abnormal function, and the shape and structure of the lips were just another part of this complex.

This question of the upward and backward movement of the incisors remained stable in some cases. Why did it not remain stable in others? With regard to the morphology of the upper incisors, were they in fact dilacerated as they erupted?

Mr. C. D. Parker, referring to a point made by Mr. Nicol, said he agreed that the relationship of the upper incisors to the lower lip was very important in determining the vertical height of these teeth. His concept was similar to Mr. Nicol's in that there was excessive vertical development of both upper and lower incisors. Part of this was due to the relation of the upper incisors to the lower lip and part due to the failure of the upper and lower incisors to develop into contact. He wished to ask Mr. Nicol about the cases where the upper incisors had

been moved forward and remained stable. Did the lower incisor position change either spontaneously or as part of the treatment?

Mr. A. J. Walpole Day, speaking of the relationship between the lip and the incisor teeth, and of lip activity, said that it was such a striking feature of these Class II, division 2 cases that one was apt to forget that this same lip–tooth relationship existed in Class I cases, in Class II, division 1 cases, and in Class III cases; in other words, there could be a very high lip line and a very active lower lip and mentalis muscle which contracted regularly in Class I and Class III cases. If one had it in a Class I case it made the upper incisors look very much like a Class II, division 2 case, and if one had it to excess in a Class I case it could even retrocline the upper incisors to such an extent that it became a functional Class II, division 2 case.

Another feature was the excessive overbite in these cases which was very often attributed to over-eruption of incisor teeth. They were perhaps overlooking the fact that in Class II, division 2 cases the molar teeth might be under-erupted; in fact, there might be overclosure. Getting back to the lip relationship, and to Mr. Nicol's suggestion that if the upper incisor teeth could be shortened, the coverage of the incisor teeth by the lower lip would therefore be reduced, and also the pressure on them; this seemed a very logical step. It was a matter of accepting the high lip line and making a high tooth line. What worried him about it was how to shorten the upper incisor teeth by pushing them up without at the same time devitalizing them.

With regard to the bending of the roots in Class II, division 2, he had always believed that once the incisor teeth had erupted and come under excessive pressure from the lips the crown was pushed backwards and the root went on developing in the same normal way. Further support was given to this by the fact that in several cases of very large labial fraenum the separation caused on the crown of the two upper centrals had separated the crowns to such an extent that the roots had become bent outwards; in other words, the root was curved and the crown divergent.

Mr. T. P. G. McCartney asked Mr. Nicol if he had ever seen the type of Class II case which was neither a division 1 nor a division 2, but had one upper central incisor retroclined and the other proclined. Had Mr. Nicol ever traced the crown–root angles in such a case?

Mr. W. Nicol, in reply, said that several speakers, including Dr. Tulley, had commented that he was only dealing with two very small features of Class II, division 2. He quite agreed with this, but felt that they were important features which had not been fully considered in the past. Further knowledge of these features was always a contribution to our overall knowledge.

Mr. Day asked a number of questions and made several comments. There was sometimes a high lip line in Class I cases. What Mr. Nicol had tried to show today was that a high lip line was one feature that must be looked at. It was also necessary to look at the shape of the lip and the slope of the inner surface, and one might find in Class I cases that one did not get this type of lower lip. This type of everted lower lip was possibly a product of the skeletal pattern which one would not have in a Class I case, but he did not think it was possible to take one little feature like this and divorce it from everything else.

Mr. Day mentioned that overdevelopment vertically of the incisors might occur, but there might also be under-development of the cheek teeth. This was, he thought, a possibility. If indeed there was distal displacement, or any abnormal path of closure, one might expect a lack of vertical development in the cheek teeth.

Mr. McCartney asked about the mixed type, where there was Class II, division 1 on one side and Class II, division 2 on the other. This type of case was quite interesting; the difference in the occlusal height of the teeth could be seen as well as the difference in the actual inclination. When the X-ray tracing was made and one tried to draw an outline of the incisors there was often difficulty in distinguishing which tooth was which.

RESEARCH REPORTS

A COMPARISON OF MAXILLARY ARCH WIDTH IN CROWDED AND UNCROWDED DENTITIONS AT 5 YEARS OF AGE.

By C. P. ADAMS, M.D.S., F.D.S., D.ORTH., School of Dentistry, Queen's University, Belfast.

KEITH (1924), reporting his investigations into differences between ancient and modern British skulls with particular reference to the development of the palate and the arrangement of the teeth, found that if average measurements were compared '. . . the differences are small . . .' and that such differences '. . . might be ascribed to mere chance'.

Smyth and Young (1932) made a detailed investigation into the form of the face and jaws, the arrangement of the teeth in normal occlusion, and included a random group of children for comparative purposes. Little stress was laid on differences in dental arch size between the normal and random groups.

Meredith and Higley (1951), investigating the relationship between face width and maxillary arch width in 'satisfactory' and 'unsatisfactory' dentitions at the age of 5–7 years, found that the ratios of dental arch width to face width for the 'unsatisfactory' cases fell within the distribution of the ratio for the 'satisfactory' cases.

The investigation described here was directed to ascertaining whether crowded maxillary dentitions were narrower than uncrowded dentitions at the age of 5–6 years or not.

The investigation was carried out in two parts: (1) Measurement investigation; (2) Mean arch dimension comparison.

1. The material used was 50 record casts from the files of the Belfast Growth Study Centre. Measurements were made interlingually and interbuccally at the upper second deciduous molars. Measurements were made twice by two observers. Analysis showed that while each observer could repeat his own observations satisfactorily, the measurements of the observers differed to a marked degree.

2. Forty-five of the cases drawn were used for the comparison of arch width. These cases were divided into two groups, crowded and uncrowded. It was found that if the mean arch widths for the two groups were compared, for the interlingual measurement the crowded arches were significantly narrower than the uncrowded arches, but that the means of the interbuccal measurements for the two groups were not significantly different. This result was found independently by both observers.

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AN ANALYSIS OF SELECTED HEREDITARY TRAITS IN A FAMILY WITH 12 CHILDREN.

By W. A. B. BROWN, L.D.S.,R.C.S., Department of Orthodontics, Queen's University, Belfast.

LATERAL and anteroposterior cephalometric radiographs have been taken for more than fifty families in which, as well as the parents, there are at least four children, with the youngest child not less than 7 years old.

To demonstrate the scope of this material, a family in which there are twelve children has been selected. In addition to the cephalometric radiographs, lateral and frontal photographs and study models have been obtained. In this family there are marked facial similarities and dissimilarities; and it is apparent that these likenesses and variations are a reflection in part of the underlying skeletal structure.

Several morphological features have been examined on the radiographs, and there would appear to be distinct morphological patterns into which the different members of the family fall.

An analysis of the teeth shows that the maxillary and mandibular buccal segments are fundamentally in normal occlusion; but for eight of the children the maxillary lateral incisors overlap the central incisors to varying degrees.

It is recognized that none of the features that have been selected for analysis is necessarily peculiar to this family, but it is thought that the high incidence with which they occur indicates a very strong genetic influence and that the subsequent examination of the other families will bring further understanding to the inheritance of the morphology of growing facial structures.

THE INCIDENCE OF ENAMEL HYPOPLASIA IN CHILDREN WITH CLEFT PALATE.

By D. A. DIXON, F.D.S., D.D.O., Consultant Orthodontist, Newcastle Regional Hospital Board.

ORTHODONTIC treatment for children with cleft palate is often rendered impracticable by the condition of the teeth. This is partly due to the ravages of dental caries, but defective structure of the teeth may also be present.

A clinical study of the teeth of patients with cleft palate has been started to attempt to separate the various dental abnormalities present in the cleft-palate dentition. Abnormalities of tooth form of congenital origin require to be distinguished from defects of environmental origin. The incidence of enamel hypoplasia of the deciduous dentition in a group of 76 children with cleft palate has been compared with that in a control group of 100 normal children. A significantly high incidence of enamel hypoplasia was found in all teeth except the lower incisors and canines in the children with cleft palate as compared with the control group.

Clinical and histological material provides some evidence of a connexion existing between this defect and the trauma of surgical repair of cleft lip and cleft palate. Ground sections have been prepared of a number of incisor teeth extracted from the margins of clefts. These revealed defects in the cervical part of the crown in the

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deciduous incisors examined, while permanent incisors showed defects of the tip of the crown and further defects in the central portion of the crown. Such defects could be related to the times of reparative surgery carried out in the individual patient.

RESEARCH INTO THE TREATMENT OF CLEFT LIP AND PALATE CONDITIONS. By A. G. HUDDART, F.D.S., D.ORTH. R.C.S., Birmingham Regional Plastic Unit, Wordsley Hospital.

THIS consists of two complementary projects to investigate the effects of different types of treatment. It is undertaken with the aid of a grant from the Research Sub-Committee, Birmingham Regional Hospital Board, and in co-operation with Mr. O. T. Mansfield and Mr. John North, Consultant Plastic Surgeons.

1. Presurgical Dental Orthopaedic Treatment. (Complete clefts of lip, alveolus, and palate.)—

a. To develop a simple technique for use in regional orthodontic clinics.

b. To investigate its effects in relation to:—

i. Preoperative changes in the shape of the upper arch.
ii. The surgical repair of the defect.
iii. The postoperative changes in arch form and occlusion.
iv. Speech, appearance, and occlusion in the older patient.
v. The early general development of the child.
vi. Early dental health education and the future general dental condition.

2. The Periodic Review of all Cleft Lip and Palate Cases under the care of Mr. John North, which have not had presurgical treatment.

a. Complete Cleft Lip, Alveolus, and Palate.—

i. To provide control cases for (1).
ii. To ascertain whether the superiority of any one sort of treatment can be demonstrated with particular reference to speech, appearance, and occlusion.

b. Postalveolar Palatal Clefts.—To investigate:—

i. Changes occurring prior to surgical repair.
ii. The effect of palatal repair on: α. Occlusion; β. Maxillary growth.

c. Lip and Alveolar Clefts.—To investigate the effect of surgical repair of the lip on maxillary growth.

INTRA-ORAL MUSCLE PRESSURE MEASUREMENT. By J. K. LUFFINGHAM, B.D.S., D.ORTH., Dental School, Guy's Hospital, S.E.1.

A SYSTEM has been developed for recording muscle pressures acting directly upon the crowns of teeth. A pickup is attached to the buccal and lingual surface of a tooth, using 'Eastman 910' adhesive. It consists of a small electropneumatic switch of 4 mm. diameter and 1·5 mm. thick, in which a rubber diaphragm is inflated intermittently by compressed nitrogen. Because movement of the diaphragm breaks an electrical circuit and cuts off the gas pressure, the diaphragm tends to vibrate at approximately 100 c.p.s. The pressure inside the switch oscillates about the pressure which is applied to the outside of the diaphragm. This fluctuating pressure may be read, smoothed electrically, and applied to a photogalvanometer.

Because of its small size the pickup can be cemented directly to the teeth of a subject without the preparation of any special mounting. Two pressure channels are available, and it is proposed to make simultaneous recordings from the buccal and lingual surfaces of selected teeth in a series of subjects during speech, swallowing, and whilst at rest. It is hoped to discover whether teeth lie in a position of muscle balance, either at rest or during speech and swallowing, and to demonstrate some quantitative correlation between muscle activity and malocclusion.

THE AETIOLOGY OF MALOCCLUSION: A FURTHER REPORT ON A COMPARATIVE SURVEY OF BRISTOL UNDERGRADUATES AND SCHOOL-CHILDREN. By J. C. STEPHENSON, F.D.S., D.ORTH. R.C.S., Bristol Dental Hospital.

THIS report is an extension of the investigation described in a previous paper (Stephenson, 1961), in which 218 undergraduates of age range 18–26 years and 311 schoolchildren of 9–13 years were compared. Findings for one observer indicated that there was a broad similarity between the two groups, with the suggestion that whilst the proportion of 'competent lip' morphologies remained the same, there was a rise in the proportion of 'incompetents with the lips held habitually together' at the expense of the groups having 'potentially competent lips' and 'incompetent lips held apart'.

The sample sizes have now been increased to include some 617 undergraduates and 614 schoolchildren, the examinations being carried out under identical conditions to those of the previous survey. Results so far suggest that the 'potentially competent' groups are mainly composed of Class II, division 1 individuals and to a much lesser extent of Class I; in the younger group the proportion of Class II, division 1 is even larger still. Class II, division 1 itself was, however, mainly found in the larger samples of 'incompetent lip' morphologies, with the 'lips held apart' group predominating. The 'competent lips' group was fractionally larger in the student sample, but the previous findings were substantially confirmed.

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THE BODILY RETRACTION OF UPPER INCISOR TEETH USING A MODIFIED BEGG ARCH

By C. D. PARKER, B.CH.D., F.D.S., D.ORTH. R.C.S.
*Eastman Dental Hospital, London**

INTRODUCTION

THE retraction of upper incisors is usually achieved by a simple palatal tilting of their crowns. However, there is a small group of cases where this type of movement is not satisfactory.

Two cases which belonged to this small group will be discussed. They had two important features in common. In both cases a considerable amount of palatal movement of the upper incisors was required to achieve the optimal incisal relationship. Secondly, there was only a small amount of bone labial to the upper incisor apices compared with the considerable amount palatal; this was clearly seen on the lateral skull radiographs. In such cases, if simple palatal tilting was used, the upper incisors would appear very retroclined and their apices would have been moved against the labial periosteum which might have caused their resorption. The retroclined relationship of the upper incisors to the lower incisors with a very deep overbite and high inter-incisal angle should be avoided if possible. When the upper incisors are retracted bodily a more normal incisal relation can be established and, in both the cases described, the final incisal relationship was Class I.

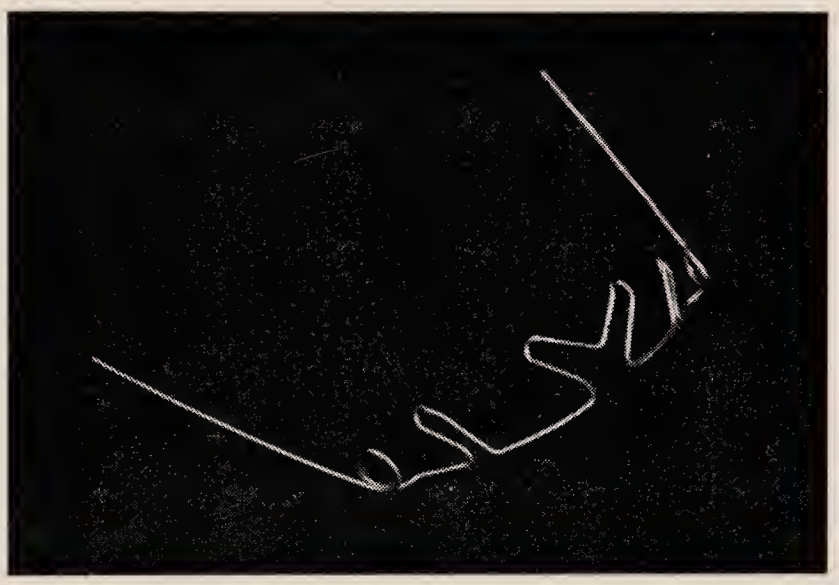

Fig. 1.—Modified 0·018-in. upper Begg arch.

Fig. 2.—Appliances used in *Case* 1 to move upper incisor apices palatally.

Fig. 3.—Appliances used in *Case* 2 to retract upper incisors bodily.

Begg (1956, 1961) described the use of vertical spurs to torque the upper incisor apices palatally, and it is a modification of this appliance which was used. Begg advocated two separate movements of the incisors to achieve bodily retraction; the first was a palatal tipping of their crowns followed by the palatal torquing of their apices. An alternative method, which I prefer, is the bodily retraction of the upper incisors as a single movement.

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Presented at the meeting held on 14 October, 1963.

Each method will be illustrated with a case report.

APPLIANCES

The materials used to construct the bands and attachments were described by Hill (1954). The brackets were pressed out of 2·5 × 0·25-mm. stainless steel tape and these attachments were placed towards the incisal tips of the upper incisors to facilitate the construction of as long a vertical spur as possible. Two types of molar tubes were used: the first was 1·0-mm. stainless steel tubing and the second was pressed out of 3 × 0·2-mm. stainless steel tape, then backed with 2 × 0·1-mm. stainless steel tape. The 1·0-mm. molar tube seen in *Fig.* 2 was approximately 5 mm. in length. An alternative molar attachment for this case would have been a tube pressed out of 5 × 0·175-mm. stainless steel tape and this might have given slightly better apical anchorage from the 6|6. The molar tube seen in *Fig.* 3 was 3 mm. in length and was pressed out of 3 × 0·2-mm. stainless steel tape. In this case, the molar tubes had to allow the archwire to slide without permitting forward tilting of the molars. It is possible that a slightly larger diameter tube might have been better, but 3 mm. was the appropriate length.

The modified 0·018-in. Begg arch (*Fig.* 1) was bent in the first instance as a level passive arch fitting into the brackets of the 21|12. The vertical spurs were in contact along their entire length with the labial surface of the 21|12. On each side of the arch a loop was inserted immediately distal to the bracket on the lateral incisor. In order to have this loop free of the canine a small horizontal step was bent into the arch immediately mesial to the loop and distal to the lateral incisor bracket. The loops had two functions: first, they acted as springs which applied palatal torque to the upper incisor apices, and, secondly, they formed a convenient attachment for traction. Having bent this passive arch, the next step was to activate it by means of horizontal and vertical adjustments. The vertical spurs were activated as the result of two adjustments to the archwire. The first was by bending the last millimetre of the vertical spur palatally. The vertical spur now had only one point of contact on the labial surface of the tooth and that was in the axial line of the tooth as far gingivally as possible. The other activation of the vertical spurs was achieved by tipping to approximately 30° the archwire distal to the traction loops. These loops were the site of reactivation of the archwire and no adjustment anteriorly was necessary. To avoid flattening of the 21|12 with proclination of 2|2, the arch was contracted to give it a Gothic arch shape. This also placed a contracting force on the buccal teeth.

As the archwire was tied in, each vertical spur in turn contacted the tooth with the archwire approximately 1–1·5 mm. in front of the centre channel of the bracket. The arch was fully tied in to the incisor teeth, then each vertical spur was lifted away from the tooth in turn with a probe to check that the pressure was the same on all the teeth. To keep the crowns of the 21|12 in contact a figure-of-eight ligature was passed around the brackets of their teeth.

Anchorage was required to resist the labial movement of the crowns of the upper incisors. Various forms of traction were used, but its continuous application was essential, otherwise the upper incisors would have become very mobile. The treatment of two patients, C. I. (*Case* 1) and C. H. (*Case* 2), will now be considered.

CASE REPORTS

Treatment.—*Case* 1.—This case had a bimaxillary proclination (*Fig.* 4 A) and was treated by extraction of $\frac{4|4}{4|4}$. The 3|3 were fully retracted with a removable appliance and $\overline{3|3}$ were fully retracted with a multiband appliance. The 621|126 were then banded and a palatal arch constructed. The 21|12 were alined and their crowns retracted, using extra-oral traction to a Johnson twin-wire arch. The $\overline{21|12}$ were retracted, using the multiband appliance. At the end of this phase of anteroposterior arch contraction, all spaces were closed in both arches (*Fig.* 4 B).

A 0·018-in. arch of the type described above (*Fig.* 1) was fitted to move $\overline{21|12}$ apices palatally. The archwire protruding from the 6|6 tubes was turned towards the gum margin, and this made the 6|6 apices part of the anchorage for torquing the upper incisor apices palatally. A lower removable appliance was inserted, from which Class II intermaxillary traction was applied to the upper archwire (*Fig.* 2). These appliances were worn for three months, and, at the end of this time, it was felt that a stable incisal relationship had been achieved (*Fig.* 4 C). The lower appliance was discarded, the upper bands removed,

and an upper retainer with the labial bow near the gingival margin was fitted and worn for three months before the occlusion was allowed to settle (*Fig.* 4 D).

The treatment of this case generally followed the principles described by Begg (1961), although the had been posteriorly positioned on the mandibular dental base.

Case 2.—This case had a Class II, division 1 incisal relationship with a developmental absence of $\overline{2|2}$ (*Fig.* 9 A) and was treated by extraction of $\underline{4|4}$. A multiband

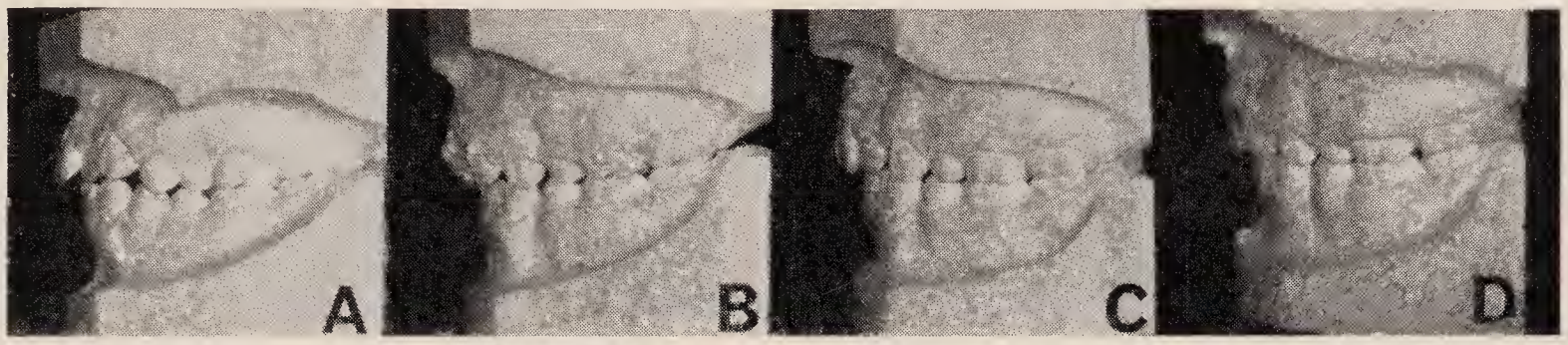
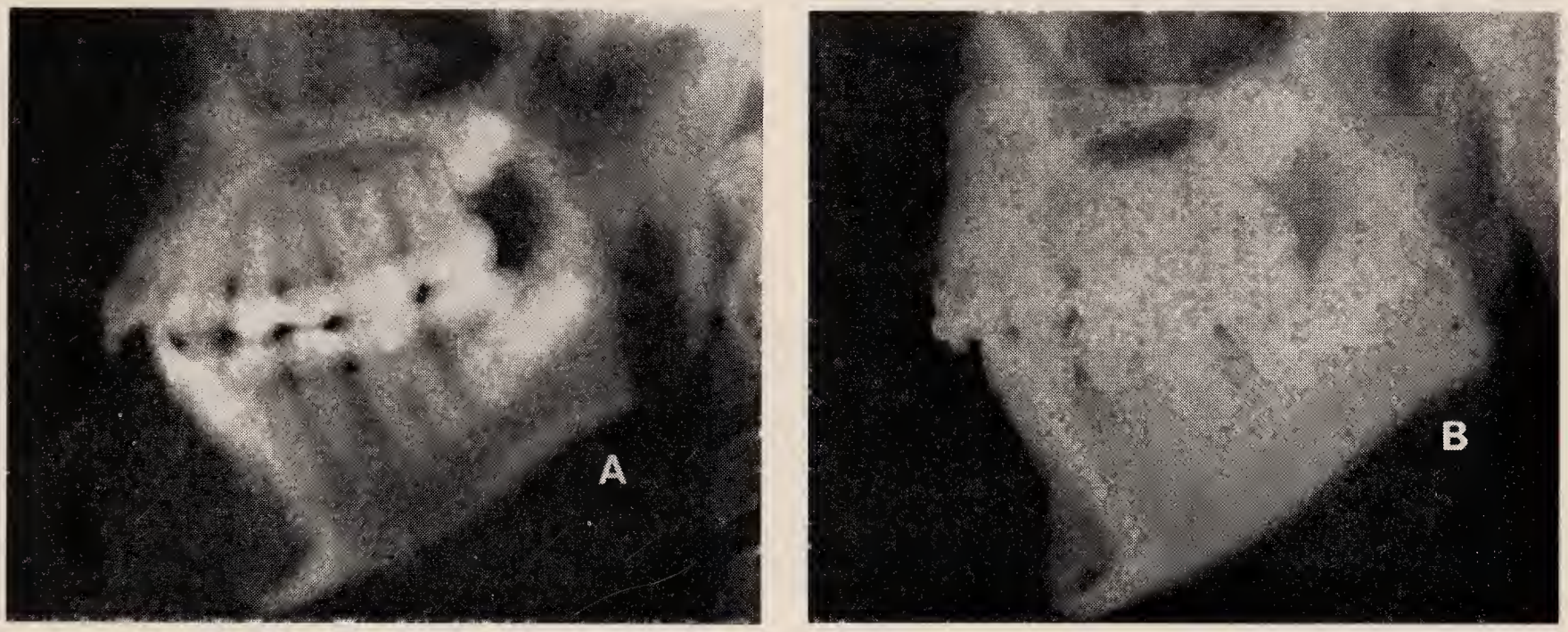


Fig. 4.—Models, left view, of *Case* 1. A, Before treatment; B, After upper and lower arch anteroposterior contraction; C, After palatal movement of upper incisor apices; D, One year out of retention.



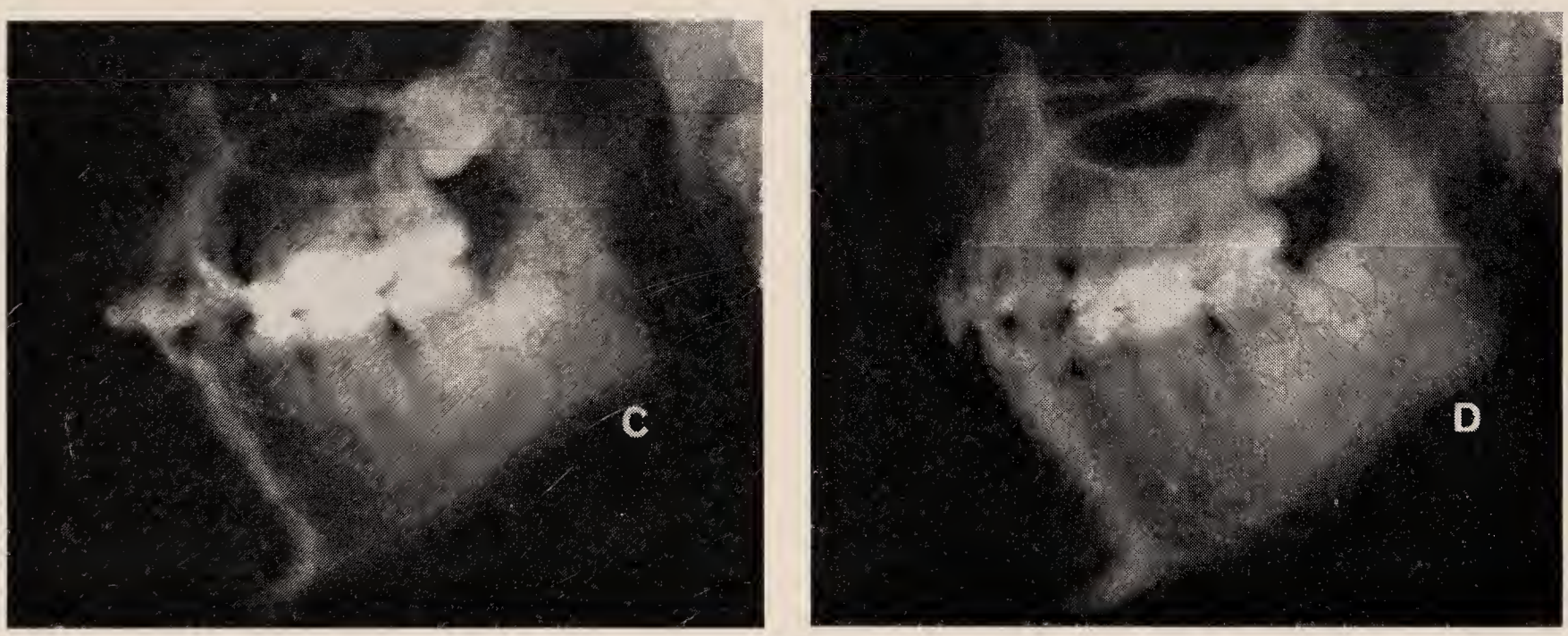
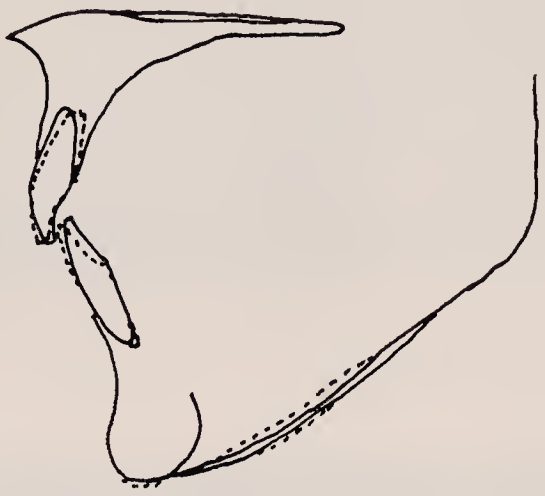


Fig. 5.—Lateral radiographs of the intermaxillary space of *Case* 1. A, Before treatment; B, After upper and lower arch anteroposterior contraction; C, After palatal movement of upper incisor apices; D, One year out of retention.

appliances were not identical. The anchorage for torquing the upper incisor apices palatally was provided by two sources—the apical anchorage of the $\underline{6|6}$, and the Class II intermaxillary traction from the lower arch which appliance was inserted to move $\underline{3|3}$ distally into contact with $\underline{5|5}$.

A 0·018-in. arch of the type described above (*Fig.* 1) was inserted to retract the $\underline{21|12}$ bodily. Later, another

0·018-in. arch of similar design was inserted, but this time with vertical spurs on 1|1 only. The reason was that the apices of 2|2 required less palatal movement than those of the 1|1. Both these archwires werc free sliding through the 6|6 tubes, and, because the buccal surfaces of the 5|5 and the 6|6 were in diffcrent planes, small horizontal steps



— 14.6.60 (*see Fig.* 5 B)

- - - 27.10.60 (*see Fig.* 5 C)

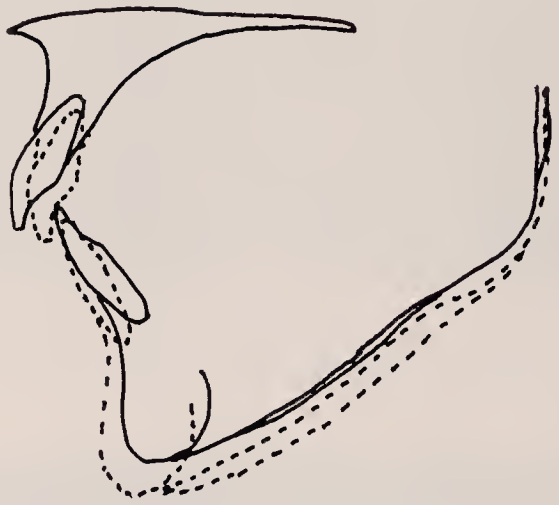
Fig. 6.—Superimposed tracings of radiographs in *Fig.* 5 B and C of *Case* 1, showing the palatal movement of the upper incisor apices.

were inserted immediately distal to the 5|5 brackets so that the arch would be free sliding. The 5|5 were lightly tied into the arch. The 3|3 were tied back to the 6|6, but not tied into the arch (*Fig.* 3). There was a small amount of archwire protruding from the 6|6 tubes but, unlike *Case* 1, this was not turned towards the gum margin. In this way, there was no possibility of the upper buccal segments being used as anchorage if the extra-oral or Class II intermaxillary traction was not worn. Extra-oral traction was applied to the upper arch by means of a headgear, the arms of which hooked into the loops distal to the 2|2 (*Fig.* 3). A lower removable appliance was inserted to provide light stabilizing Class II intermaxillary traction during the day, while the extra-oral traction was worn in the evening and at night. This apparatus was worn for twelve months; at the end of this timc, too much palatal movement of the 21|12 apices had been achieved (*Fig.* 9 B). The upper bands were removed and an upper removable appliance fitted with the labial bow activated towards the incisal tips of 21|12 to move these palatally (*Fig.* 9 C). Treatment was then discontinued, and the occlusion allowed to settle (*Fig.* 9 D).

Table I.—Readings from the Tracings of the Lateral Skull Radiographs of *Case* 1

	A 16.2.59	B 14.6.60	C 27.10.60	D 24.3.62
$\frac{1}{}$–Mx	116°	99°	108°	108°
$\frac{\bar{1}}{}$–Md	97°	83°	91°	85°
$\frac{1}{\bar{1}}$	115°	145°	129°	136°
Mx–Md	32°	33°	32°	31°
SNA	79°	79°	79°	79°
SNB	73°	73°	73°	74°
ANB	6°	6°	6°	5°
N–S–GN	75°	75°	75°	74°

This treatment contrasted with Begg principles in many ways, but I would like to emphasize the bodily retraction as a single movement of the upper incisors. The anchorage for the bodily retraction of the upper incisors was mainly extra-oral and the light Class II intermaxillary traction was used for stabilization.



— 16.2.59 (*see Fig.* 5 A)

- - - 24.3.62 (*see Fig.* 5 D)

Fig. 7.—Superimposed tracings of radiographs in *Fig.* 5 A and D of *Case* 1, showing the bodily retraction of the upper incisor teeth.

Analysis of Changes

Case 1 (Born 25 May, 1946).—Record models (*Fig.* 4) and lateral skull radiographs (*Fig.* 5) were taken at four stages:—

A, 16.2.59—Before treatment.

B, 14.6.60—After upper and lower arch anteroposterior contraction.

C, 27.10.60—After palatal movement of upper incisor apices.

D, 24.3.62—One year out of retention.

The lateral skull radiographs were traced and certain angles were measured and recorded (*Table I*). These angles give a valuable guide to the behaviour of the incisors, the relationship of the dental bases, and the growth of the face.

The tracings of different stages were superimposed on their palatal shadows and maxillary planes to determine the movement of the upper incisors with respect to the upper jaw. The tracings of the radiographs in *Figs.* 5 B and C were superimposed to give the changes during the time the modified Begg arch was worn (*Fig.* 6). A similar procedure was carried out with the tracings of the radiographs in *Fig.* 5 A and D to give the overall changes (*Fig.* 7).

Changes while Modified Begg Arch Worn (Period B–C).—During this period the N–S–GN, SNB, and ANB angles were constant. These findings were consistent with normal facial growth with no change in dental base relationship (*Table I*).

Within the intermaxillary space the upper incisor apices were moved palatally 2 mm. while the incisal tips moved less than 1 mm. labially; they pivoted about a point in the crown of the tooth (*Fig.* 6). This resulted in the upper incisors proclining 9° (*Table I*). The lower incisors proclined 8° under the influence of Class II intermaxillary traction.

The changes in thc occlusion (*Fig.* 4 B, C) were purely the result of the teeth altering their position on the dental bases.

Overall Changes (Period A–D).—After the appliances were discarded, there was a 1° reduction in the N–S–GN and ANB angles. The occlusion during this time changed very little (*Fig.* 4 C, D) apart from 6° retroclination of the lower incisors (*Table I*). For the overall period, facial growth was assessed as normal.

The overall changes within the intermaxillary space were the reduction of the bimaxillary proclination with 8° retroclination of the upper incisors and 12° retroclination of the lowers (*Table I*). The upper incisors were retracted bodily, pivoting about a point several millimetres above their apices (*Fig.* 7). This change in the occlusion was associated with a change in the posture and behaviour of the lips which can be seen on the photographs of the patient before and after treatment (*Fig.* 8).

Case 2 (Born 18 May, 1945).—Record models (*Fig.* 9) and lateral skull radiographs (*Fig.* 10) were taken at four stages:—

A, 27.7.56—Before treatment.

B, 5.5.59—After bodily retraction of upper incisors.

C, 26.8.59—End of active treatment.

D, 2.4.62—Two years out of retcntion.

The lateral skull radiographs were traced and the angles recorded (*Table II*). As in *Case* 1, superimposed tracings were prepared. *Fig.* 11 covers the period (A–B) when the modified Begg arches were worn, and *Fig.* 12 the overall period (A–D).

Changes while Modified Begg Arch Worn (Period A–B).—During this period, thc N–S–GN angle was constant, which is consistent with normal facial growth (*Table II*). There was no change in the SNB angle, but the SNA angle reduced by 1°; this was probably the result of the upper incisor apices moving palatally and does not represent a change in dental base relationship. The Mx–Md planes angle closed 2° which is the normal growth trend and, again, this was not taken as a ehange in dental base relationship.

Within the intermaxillary space the upper incisors were retracted bodily 4 mm. (*Fig.* 11) with virtually no ehange in the angulation of the teeth (*Table II*). The angulation of the lower incisors was also unchanged.

Fig. 8.—Profile photographs with lips at rest and full-faee photographs with lips sealed of *Case* 1. A, Before treatment; B, After treatment.

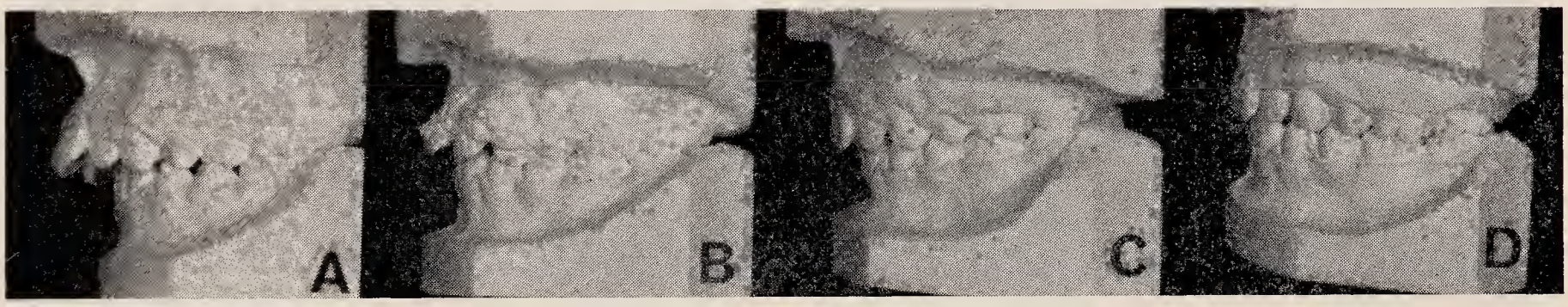


Fig. 9.—Models, left view, of *Case* 2. A, Before treatment; B, After bodily retraction of the upper incisors; C, End of active treatment; D, Two years out of retention.

Table II.—Readings from the Tracings of the Lateral Skull Radiographs of *Case* 2

	A 27.7.56	B 5.5.59	C 26.8.59	D 2.4.62
$\frac{1}{1}$–Mx	126°	125°	114°	112°
$\frac{1}{1}$–Md	100°	100°	100°	103°
$\frac{1}{1}$	106°	109°	121°	123°
Mx–Md	28°	26°	25°	22°
SNA	79°	78°	78°	77°
SNB	75°	75°	75°	75°
ANB	4°	3°	3°	2°
N–S–GN	67°	67°	67°	67°

As in *Case* 1, the changes in the occlusion while the Begg arch was worn (*Fig.* 9 A, B) were thought to be simply the result of the teeth altering their position on the dental bases.

Overall Changes (Period A–D).—Facial growth, as judged by the N–S–GN angle, appeared normal (*Table II*). The ANB angle decreased from 4° to 2° by a relative palatal movement of 'A' point, while the SNB angle was

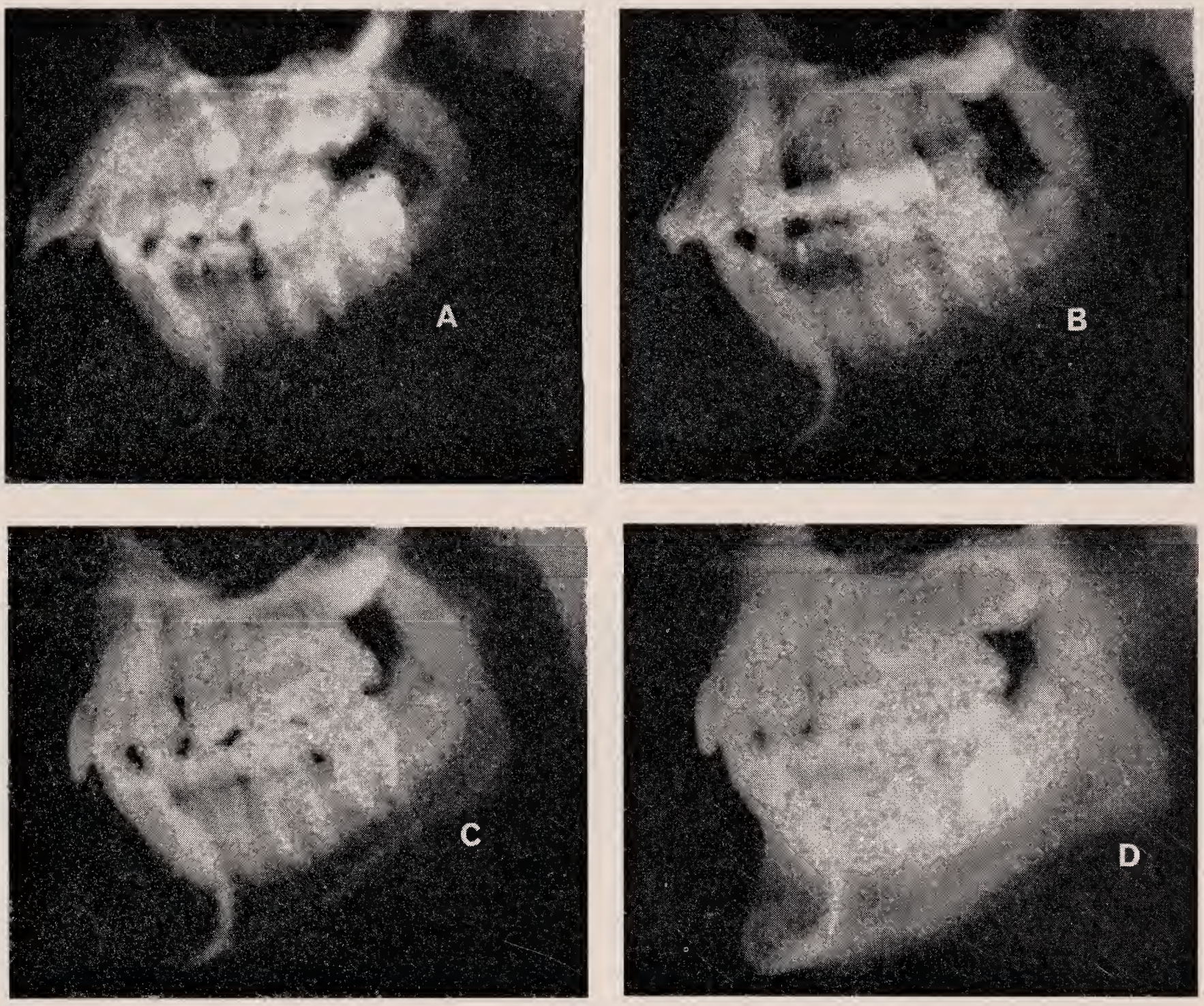
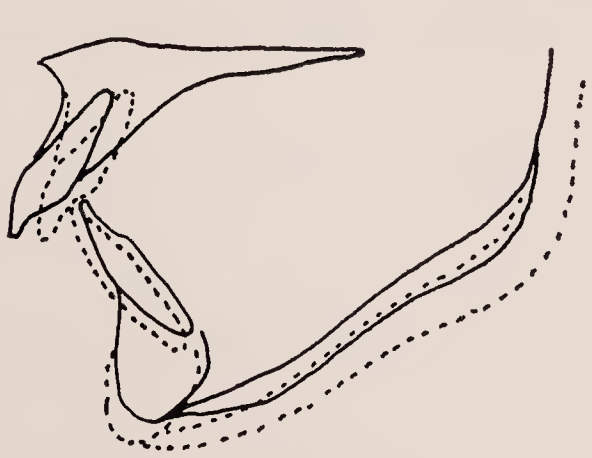


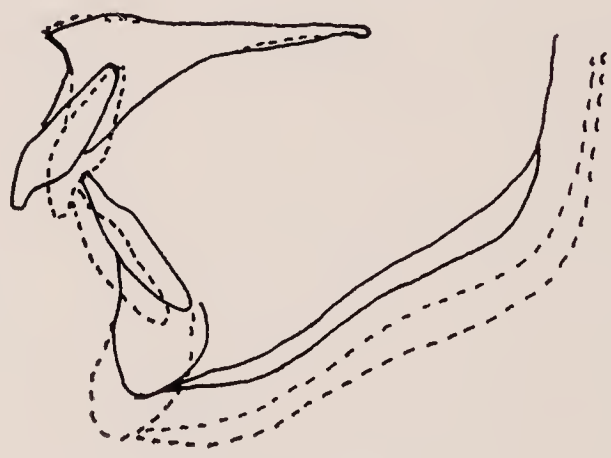
Fig. 10.—Lateral radiographs of the intermaxillary space of *Case* 2. A, Before treatment; B, After bodily retraction of the upper incisors; C, End of active treatment; D, Two years out of retention.



— 27.7.56 (*see Fig.* 10 A)

- - - 5.5.59 (*see Fig.* 10 B)

Fig. 11.—Superimposed tracings of radiographs in *Fig.* 10 A and B of *Case* 2, showing bodily retraction of the upper incisors with no change of angulation of these teeth.



— 27.7.56 (*see Fig.* 10 A)

- - - 2.4.62 (*see Fig.* 10 D)

Fig. 12.—Superimposed tracings of radiographs in *Fig.* 10 A and D of *Case* 2, showing the bodily retraction of the upper incisor teeth.

unchanged. The Mx–Md planes angle progressively decreased 6°, but this was not thought to be significant. Parker (1963), in a growth study of children with untreated occlusions, found only 1 child in 33 where the Mx–Md planes angle decreased by as much as 6°. However, it must be stressed that the behaviour of this angle is very variable. The angular changes in *Case* 2 were not thought to represent a change in dental base relationship, only a remoulding of the alveolar process in the region of 'A' point.

Within the intermaxillary space, there was a change of occlusion from Class II, division 1 (*Fig.* 9 A) to Class I (*Fig.* 9 D). The upper incisors were retracted bodily, pivoting about a point several millimetres above their apices (*Fig.* 12) as they retroclined 14° to achieve the patient's optimal incisal relationship (*Table II*). The lower incisors proclined 3°.

DISCUSSION OF THE TWO METHODS OF RETRACTION

Although bodily retraction of the upper incisors was achieved in both cases, in the method advocated by Begg (1956, 1961) it required two movements of the upper incisors whereas the alternative method only required a single movement.

The advantage of Begg's method is the anchorage created by allowing the posterior teeth to tilt forward as the incisors are tilted lingually during the phase of anteroposterior arch contraction. The posterior teeth are then used as reciprocal root anchorage for the palatal movement of the upper incisor apices; this anchorage is available in both arches. A sufficient number of teeth are extracted to make the use of extra-oral traction unnecessary. To my mind, there are two main disadvantages in this method. The first is that as upper incisors are retracted their apices move against the labial periosteum which may cause their resorption. The second disadvantage results from tipping the lower incisors lingually during lower arch contraction. Later, the use of Class II intermaxillary traction causes the lower incisors to move labially, and when their crowns are in the same position as before treatment the teeth often appear retroclined. Therefore, the useful clinical and cephalometric guide of lower incisor angulation is unreliable.

It would seem that the Begg technique besides requiring a high degree of skill also calls for considerable clinical judgement.

The alternative method of bodily retraction has the advantage that all the apical movement of the upper incisors is in the required direction and that the apices do not come into close relation with the periosteum. The total amount of apical movement is considerably less than in the Begg method. The anchorage problem was solved by using extra-oral and light Class II traction. More Class II intermaxillary traction would have been used if it had been available, but using a 0·018-in. arch I have some doubt as to whether Class II traction alone, without extra-oral traction, would be sufficient to retract the upper incisors bodily. In *Case* 1, where intra-maxillary and Class II anchorage were used, there was some labial movement of the crowns of the upper incisors. An answer to this anchorage problem may well be found by using a thinner gauge of wire exerting a gentler force over a greater distance, but at the time this appliance was first used, the 0·018-in. high-tensile wire was the only one with sufficient resilience. This was the reason why 0·016-in. wire was not used, as advocated by Begg.

A certain amount of apical resorption of the 21|12 occurred in both cases, but it was more marked in *Case* 1. Ballard (1960) suggested that there may be two different causes. In *Case* 1 the resorption was thought to be the result of the apices first moving against the labial and later the palatal periosteum. In *Case* 2 the resorption may have resulted from 'jiggling' the incisor teeth during their retraction. This was thought to be mainly the result of poor patient co-operation in the wearing of both the extra-oral and intermaxillary traction.

The apical resorption of the upper incisors and the involved nature of these appliances indicate that this treatment should only be prescribed in those few cases where considerable palatal movement of the upper incisors is indicated and there is very little bone labial to the apices of these teeth.

Acknowledgements.—I would like to thank Professor C. F. Ballard for permission to report on these children whom I treated at the Eastman Dental Hospital, London. I am grateful to Mr. N. M. Potter of the Photographic Department for his help, particularly with the clinical demonstration at the

Country Meeting of the British Society for the Study of Orthodontics, in Edinburgh in May, 1962. I would also like to thank Miss S. C. Davis and Miss J. F. Jeffery for typing the script.

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DISCUSSION

Mr. F. Allan said that the trouble with the Begg arch was that even after the most skilful construction one did not know what was happening. His own method was very much more simple, controllable, and adjustable. As soon as the canines were in place, the four upper incisors were banded in the usual way. A removable appliance was then made, and anchored on as many teeth as considercd necessary. A low labial arch with take-up loops and/or coil for inter- or intra-maxillary anchorage was constructed in such a way that the archwire would rest above the brackets of the incisors banded. The wire was then slipped below the brackets, moving the teeth palatally and upwards. Either of thcse directions could be accentuated by requisite pressure, and the pressure itself could be easily measured with a gauge. A similar appliance could be constructed in the lower arch, but a bite plane should be addcd postcriorly, or the brackets would be bitten off in a typical Class II, division 2 case.

Mr. H. L. Leech said that Mr. Parker had stated that the objection to using a round arch was that it allowed the forward movement of the apices of the upper incisors against the labial bone, resulting in resorption. How many such cases of resorption had he seen? In both the cases he showed, he admitted he had resorption of the apices. Also, how long had he observed cases out of retention? Were they stable?

Mr. Smith asked, taking the resorption factor further, in skilled hands was devitalization going to take place?

Mr. B. S. Cryer asked, first, whether he thought the amount of pressure put on the teeth could be controlled accurately by gauges, or did he go on the purely subjective value that the patient said it did not hurt?

If he found difficulty in exerting a constant pressure on the teeth with the anchorage he used—extra-oral or intermaxillary—did he think it possible to use intra-maxillary? If, in the second case, he had used a removable appliance instead of a fixed one for retraction of the canines, could he have used additional anchorage saved thereby for intramaxillary traction?

Mr. C. P. Briggs said that in his second case Mr. Parker, in using a fixed appliance in the upper arch, was accepting forward movement of the anchor molar. He wondered whether Mr. Parker had considered the use of something like a second-order bend as a form of anchorage preparation, as advocated by Tweed and his associates, using the edgewise mechanism?

Mr. V. C. West asked Mr. Parker why he chose this method rather than a full Begg technique, which, theoretically, would have achieved the same result?

His own idea of the Begg technique was what Mr. Parker called the universal movemcnt, and this implied that in cases other than where he used his expansion loops, this treatment was performed with one preformed arch, which, indeed, did give bodily movement of the upper incisors, not movement in two stages as represented on the blackboard. Mr. Parker had said that the movement was parallel and yet mentioned the point of rotation of the tooth. He asked Mr. Parker to clarify that.

Mr. C. D. Parker, replying, said that he did not believe that in the majority of Class II, division 1 cases it was required to depress the upper incisors, in fact it was contra-indicated. His work on the Chapman Prize Essay showed, in most cases, that the upper incisors required to be moved down and that it was the lower incisors that required to be depressed. He had not used a combination of removable appliances with bands on the upper incisors, but thought it had interesting possibilities.

Answering Mr. Leech, he said that there was apical resorption of the upper incisor teeth in both cases. He had seen quite a number of cases where the roots of the upper incisor teeth had been moved against the periosteum and the root apices were resorbed. In the second case, had there not been such poor co-operation from the patient which resulted in a jiggling backwards and forwards of the tecth, thcre might well have been considerably less resorption. It was more important that a Class I incisal relationship was achieved and in both the cases described the teeth were very firm.

Mr. Smith had asked about devitalization. He had not devitalized any teeth with this appliance, but, on occasions, the upper incisors had become very loose when adequate traction was not applied.

His experience was that once the teeth had become loose during treatment an excessive pressure could be applied to thcm without apparently causing the patient any pain. Therefore, pain was not a sound basis to judge activation. From experience the appropriate activation was learnt and such aids as gauges were of little use as the forces were far too complex to accurately evaluate. Mr. Cryer must have been looking at the case notes, as the author had tried to move the canines back with a removable appliance; this was not well tolerated and so a banded appliance was used.

Mr. Briggs had raised the point about anchorage. In the second case he did not use the upper buccal segments as anchorage because no forward movement of these teeth could be allowed. If the extra-oral and Class II intermaxillary traction were not worn, the only result was that the upper incisors moved forward. He thought that the 0·018-in. modified Begg arch required considerable anchorage. He would try a small tip back bend, but this would tend to impede the sliding of the archwire, and probably was of little value in creating anchorage.

Mr. West had asked why a full Begg tcchnique had not been used. He had the fecling that it was unnecessarily complicated. He had tried to pick out the points he thought were important in the Begg technique. Begg described three stages. In the first he corrected buccal segment antcroposterior relationships and decreased overbite. In the second, he closed spaces with the result that the appearance of the incisors could be very worrying. In the final stage, he put the teeth into what he described as acceptable angular relations. The two cases the author described were not complicated by crowding and so illustrated quite simply two methods of moving the upper incisor teeth palatally.

ANGLE'S CLASS II, DIVISION 2

By H. E. WILSON, L.D.S. (Q.U.BELF.), D.ORTH. (ENG.), D.D.O. (GLASG.)
Consultant Orthodontist, The London Hospital Dental School

THE most common treatment of Angle's Class II, division 2 type of malocclusion in this country is the bilateral extraction in the upper arch of first premolars and the retraction of upper canines and lateral incisors, the position of the central incisors being accepted. Occasionally, in cases of distal displacement of the mandible which are thought to be rare, the upper incisors are proclined (Tulley and Campbell, 1960; Walther, 1960).

The purpose of this part of the symposium is to show that this is wrong, and that in the majority of cases the extraction of upper first premolars and retraction of upper canines and lateral incisors is poor treatment, and if extractions are necessary in these cases, then teeth more posteriorly sited than premolars should be extracted.

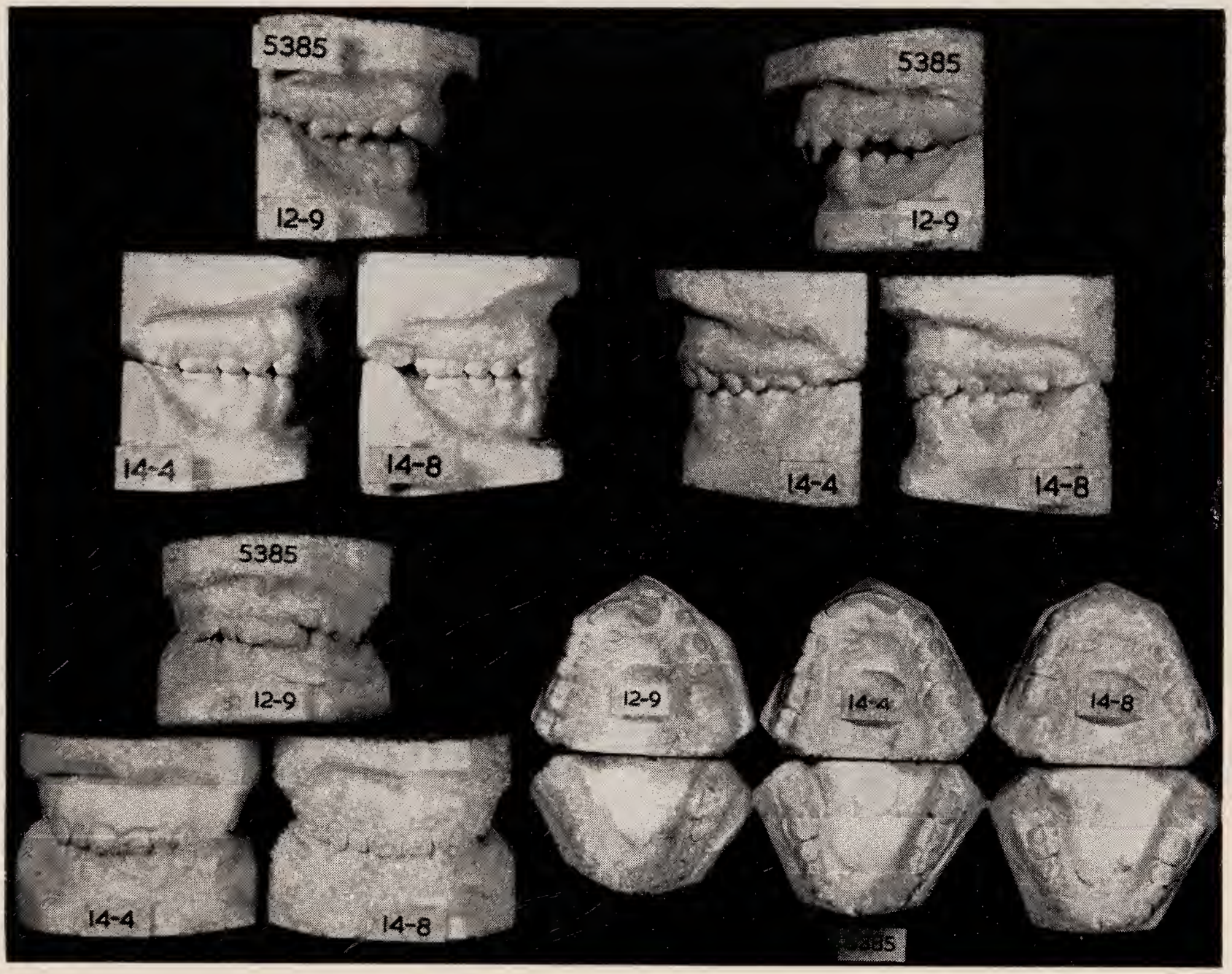


Fig. 1.—The models of a boy treated by upper removable appliances. There was a marked change in arch relationship and incisal overbite. The slight crowding in the lower arch remained unchanged.

Fig. 1 shows the models of a patient treated with an upper removable appliance. The crowding in the lower incisor region remained, and, for this reason, lower second molars were extracted. The left upper third molar was missing, so only the right upper second molar was extracted to compensate for the extractions in the lower arch.

Part of a Symposium presented at the Country Meeting held at Norwich on 18 May, 1963.

Fig. 2 shows an example of a patient treated without extraction. There has been a slight relapse after three years out of retention, but the result is far better than could have been obtained by extraction of premolars.

Class II, division 2 malocclusions may be divided into those with, and those without, abnormal paths of closure (Dickson, 1956). When there is no abnormal path of closure, overbite and the freeway space are usually

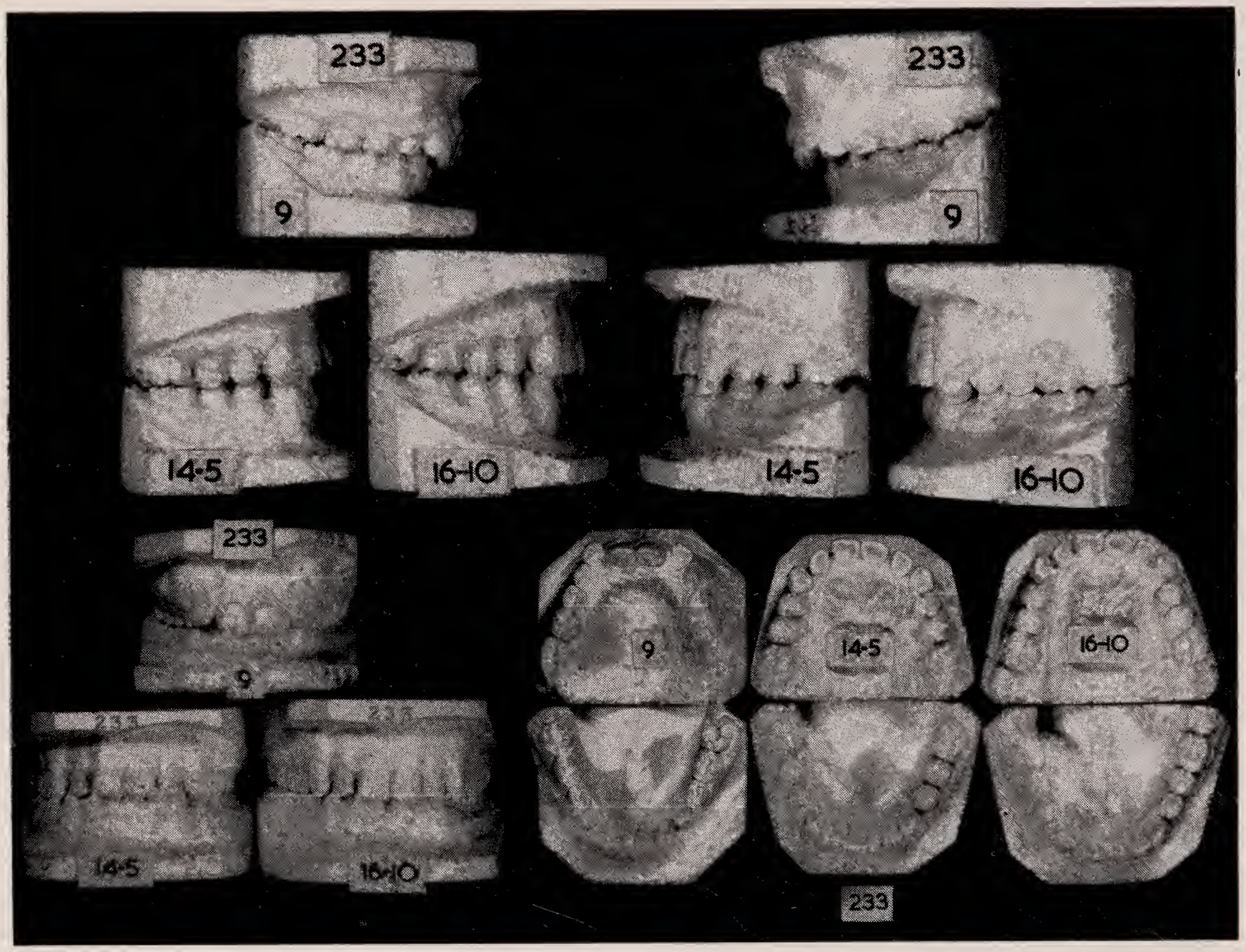


Fig. 2.—Typical Class II, division 2 occlusion, first treated in mixed dentition with upper removable appliance. At final visit at age of 18 years, there was no further relapse although there was spacing in upper and lower arches.

Fig. 3 illustrates an example of a Class II case treated by extraction of four first premolars. The result was good aesthetically, but very poor functionally. There was a grossly excessive overbite and a marked mandibular displacement. The patient on this occasion was seeking treatment for temporomandibular joint symptoms. It was considered that her symptoms were associated with the dental occlusion. The treatment was to procline the upper incisors, and, as this proceeded, the joint symptoms reduced in intensity and frequency until they finally disappeared. There was no relapse some two years later.

within normal limits or only slightly excessive. They resemble more Class I cases with mesial movement of upper buccal segments and crowding out of canines and should perhaps be more truly classified as Angle Class I. Treatment of these cases by the extraction of premolars will not only allow for the reduction of the crowding, but may also produce some slight reduction of the overbite. The question of excessive spacing may have to be considered.

In cases where there is a mandibular displacement the extraction of premolars does rarely allow for the reduction of the overbite

and certainly not for the correction of the mandibular displacement. The deep overbite is maintained (Leech, 1961) which, however aesthetically good, can be associated with disturbing symptoms years later, either in the temporomandibular joint and/or by trauma to

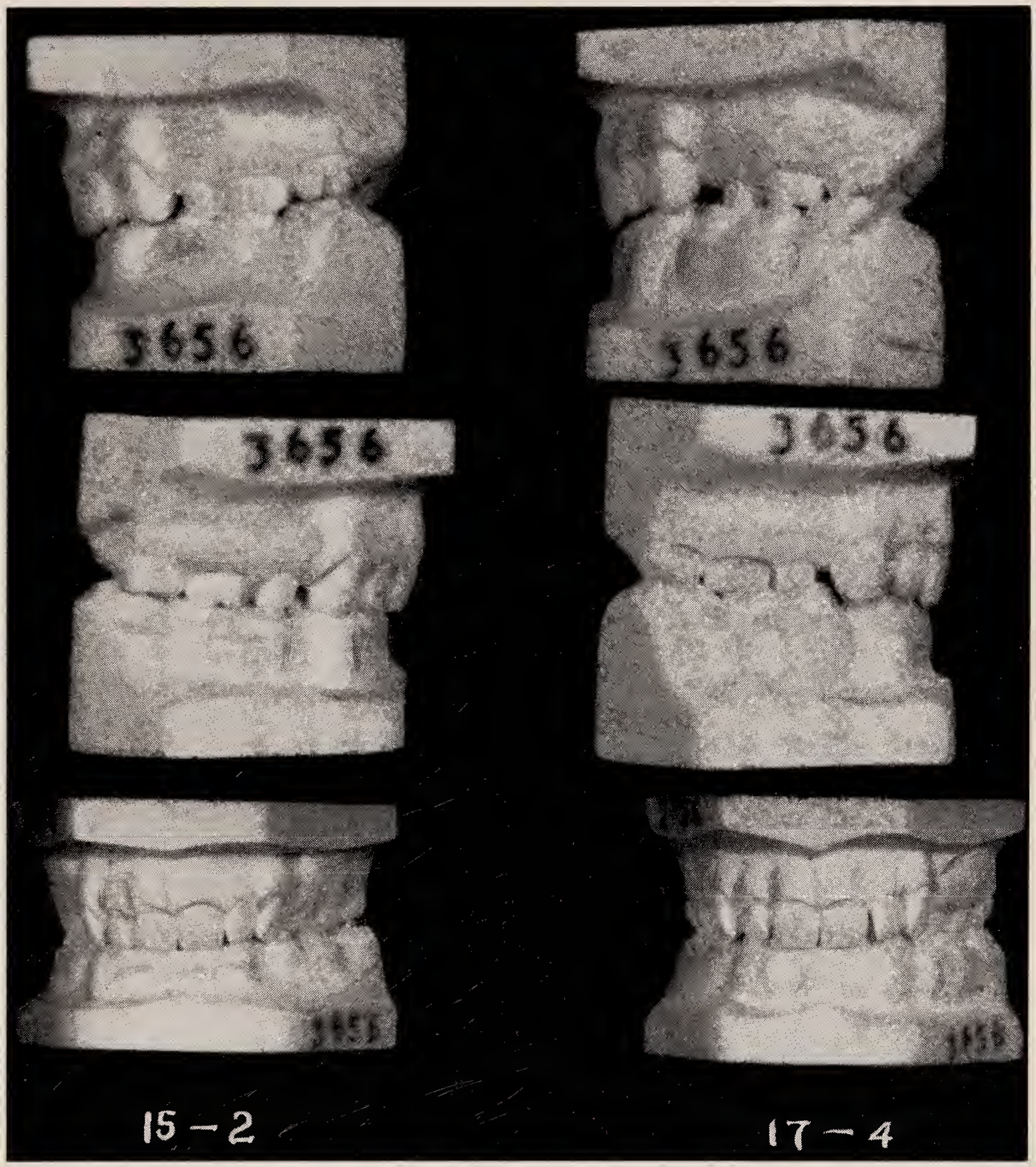


Fig. 3.—Models of a patient who presented with temporomandibular joint symptoms. Her occlusion was originally Class II, division 2 and was treated by extraction of four first premolars resulting in deep overbite and mandibular displacement. This condition was then treated by upper removable appliance to move upper incisors labially. *Lower* photograph shows the patient ten months out of retention with marked reduction in overbite.

the gingivae (Wilson, 1952, 1953, 1957). The maintenance of the excessive overbite and mandibular displacement is poor treatment. These are undesirable features in an occlusion, and where possible should be corrected. It is not claimed that all treatments are completely successful, but this is no justification for not attempting it. All the cases described here are of this type.

Fig. 4.—There was partial correction of the postnormality with an upper removable appliance for this patient. Treatment was completed by extra-oral anchorage.

Fig. 4 shows the models of a case where the treatment by a simple removable appliance was not successful and treatment was

completed with extra-oral anchorage. Second molars were not extracted, and the patient has been three and a half years out of retention.

DIAGNOSIS

The diagnostic technique is straightforward, but not necessarily simple. The only aid required is a good set of models. Lateral skull X-rays are unnecessary and unreliable and may be used only to explain what has happened as a result of treatment (Björk, 1960). The rest position of the mandible is determined clinically, the patient being observed during normal function and speech.

The unmounted models are positioned free-hand in the rest position and then brought into occlusion. By this method, not only is the mandibular path of closure seen but felt, and much greater dynamic conception of it obtained. Wear facets are also looked for on the models. These facets and the type of mandibular movement are then confirmed clinically. Careful observation of the pattern of wear facets can build up a more reliable picture of the mandibular movement than any technique depending on mechanical aids such as anatomical articulators. The tongue position and behaviour and the freeway space are also observed while determining the patient's rest position.

Mandibular displacement is usually accompanied by displacement of the condyles, and in Class II, division 2 is usually bilateral. Confirmation of this can be obtained by placing the little fingers in the external auditory meatuses and instructing the patient to close from the rest position, when the condyles can often be felt partially occluding the external auditory meatuses to varying degrees.

Not one of these diagnostic features is absolutely reliable in itself, but together they form a reliable diagnostic technique.

'Clinical experience', which during the era of the 'scientific approach' was much out of favour and considered old-fashioned, is now being again accepted as something of considerable value. The clinician with the longer experience who carefully assesses his patients individually is being recognized as more reliable than the younger man with his gadgets on which he relies so much (McKeag, 1960). The person who depends on his instruments will go only as far as the instruments allow; he will fail to develop his powers of observation, clinical assessment, and clinical sense, which if developed, will take him much further, albeit more laboriously and with less early conviction. He will say less, be less dogmatic, but will also have cause to change his mind less frequently (Selmer-Olsen, 1960).

If the arch relationship is assessed in the rest position rather than in occlusion, then many postnormal relationships would appear normal; or a normal, or slightly postnormal, arch relationship in the rest position then becomes a postnormal arch relationship in occlusion. Then the type of treatment described here may appear less illogical. Others hold the opinion that the position here described as the 'rest position' is due to a forward posturing of the mandible and is not a true rest position. There seems to be no reason why an individual with Class II, division 2 malocclusion should posture forward other than to prevent discomfort within the joints.

Fig. 5 A shows the tracings of a cephalometric head-plate of a patient before and during treatment; the top left being taken with the mandible in the rest position, and the top right taken eleven months later in occlusion. When superimposed, there is no difference in these tracings except in the incisal angles, as shown in the two lower tracings.

Fig. 5 B shows the models of the same patient. The lower second premolar on the left is congenitally missing.

TREATMENT

These Class II, division 2 cases have three features in common:—

1. Large freeway space (interocclusal clearance).
2. Distal or backward displacement of the mandible on closing from the rest position with similar movement of condyles.
3. Tooth-apart swallow with lateral tongue thrust, sometimes with concomitant speech defect.

When these conditions exist, the treatment is planned to move the upper central incisors

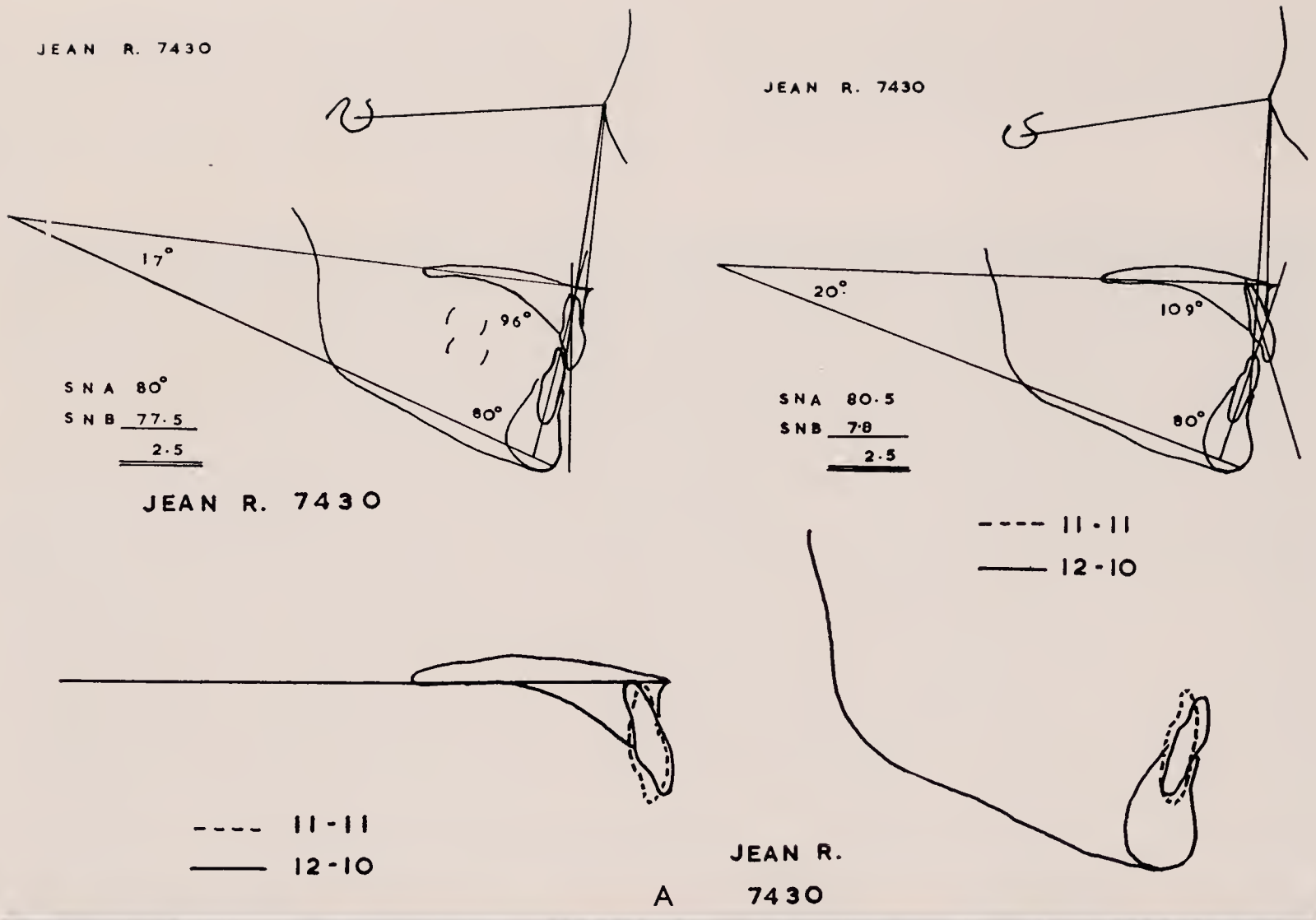


Fig. 5.—A, Cephalometric tracing of a patient under treatment. *Top left* is the tracing of the headplate before treatment commenced, but in the resting position. Although the arch relationship has changed (B), there is no change between the two tracings; the second one was taken with the teeth in occlusion. The only noticeable change is the inclination of upper and lower incisors which has been achieved by some palatal and lingual movement of the apices of the incisors as well as labial movement of the crowns.

labially so that the mandibular movement from rest to occlusion will become more normal. The treatment has been attempted in cases where no mandibular displacement was observed but suspected, and has had some success.

The treatment itself is simple. A removable appliance with two curved springs crossed behind the incisors to move them labially is used. The type of spring, usually 0·5 mm. in diameter, is reasonably important. Shorter springs have limited range of movement, less adaptability, and require replacement more frequently. The design of the guide plane is also important. It should be steep and accurately made. In the waxed-up stage, the lower incisors are pressed into the wax in such a way that the bite is gagged and the mandible guided forward. As treatment progresses, additions are made with cold-cure acrylic to the guide plane, usually by asking the patient to bite with a more forward position into the uncured acrylic. When completely cured, the guide plane is then trimmed and polished.

DISCUSSION

What happens, apart from the correction of the postnormality, it is difficult to say. One can say without much doubt that the upper and lower incisors are proclined, the deep overbite is reduced or eliminated, and the arch relationship in oeclusion is changed. This is what is clinically desired and may be due to the elimination of the abnormal path of closure. However, in some cases there must be some changes elsewhere. What these are one cannot say, but some suggestions can be made. The changes may be within the joints, say in the relationship of the condyles to the fossae, or in growth direction, or in the relative rate of development. This does not fit the present conception of dental base relationship and soft-tissue morphology and behaviour, and it would appear that there has been an over-simplification of these points.

Fig. 6 A shows the tracings of a patient still under treatment, the top left being the one taken before treatment started, and the middle top the one taken fifteen months later. On the right, these two tracings are superimposed on the nasion and the SN plane. There was an interruption of some months in the treatment between the taking of these two headplates.

In addition to the change in the incisal angles, as shown in the lower tracings, there is a change in the arch relationship. Apparently this is due to repositioning of the mandible, which has been maintained, and is not a forward posturing position.

Fig. 6 B illustrates the models of this patient and shows marked change in arch relationship in six months. The crowding in the lower arch is to be treated by extraction of lower second molars. The upper second molars will also be extracted.

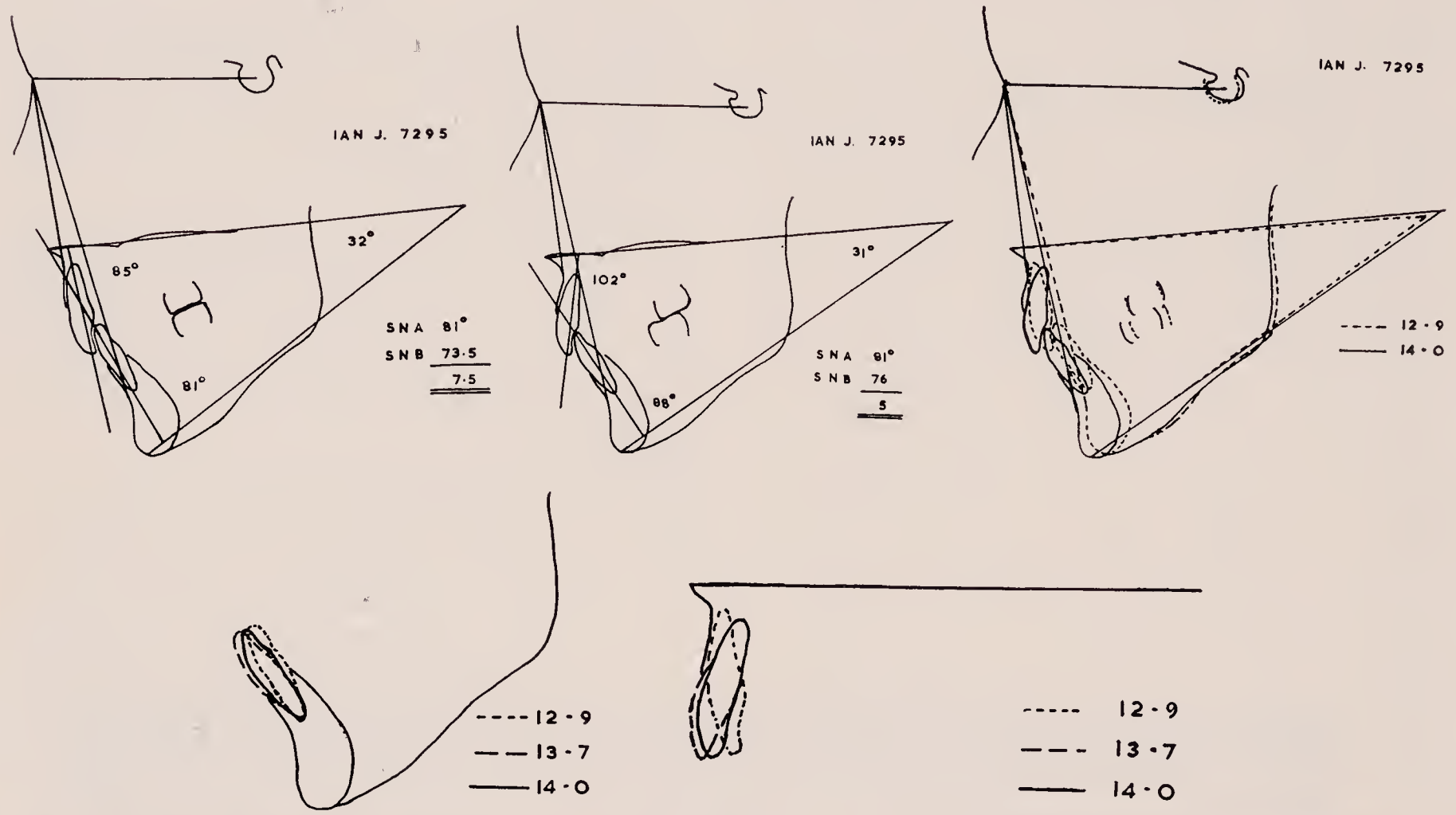
Class II, division 2 occlusions do not have a similar aetiology, but one hears or reads that the 'diagnosis' is Class II, division 2. This is not a diagnosis, but merely a description of the condition which may be due to different or multiple factors (Ridley, 1960). Diagnosis is the determination of the aetiology. Before this can be done, all the factors involved must be recognized, and, having been recognized, their relative importance assessed. Herein lies the most difficult art and it must always be subjective. It is here that clinical experience is most important and gadgets the least important.

There is no such thing as a simple approach to the diagnosis and treatment planning of this condition—or indeed any other condition. It can only be said that it is still necessary to examine every case carefully and fully, and with patience, to develop the skill necessary to make an accurate diagnosis. The treatment may then be planned for the condition that exists in the individual patient, even although such treatment may be unusual and with a doubtful prognosis.

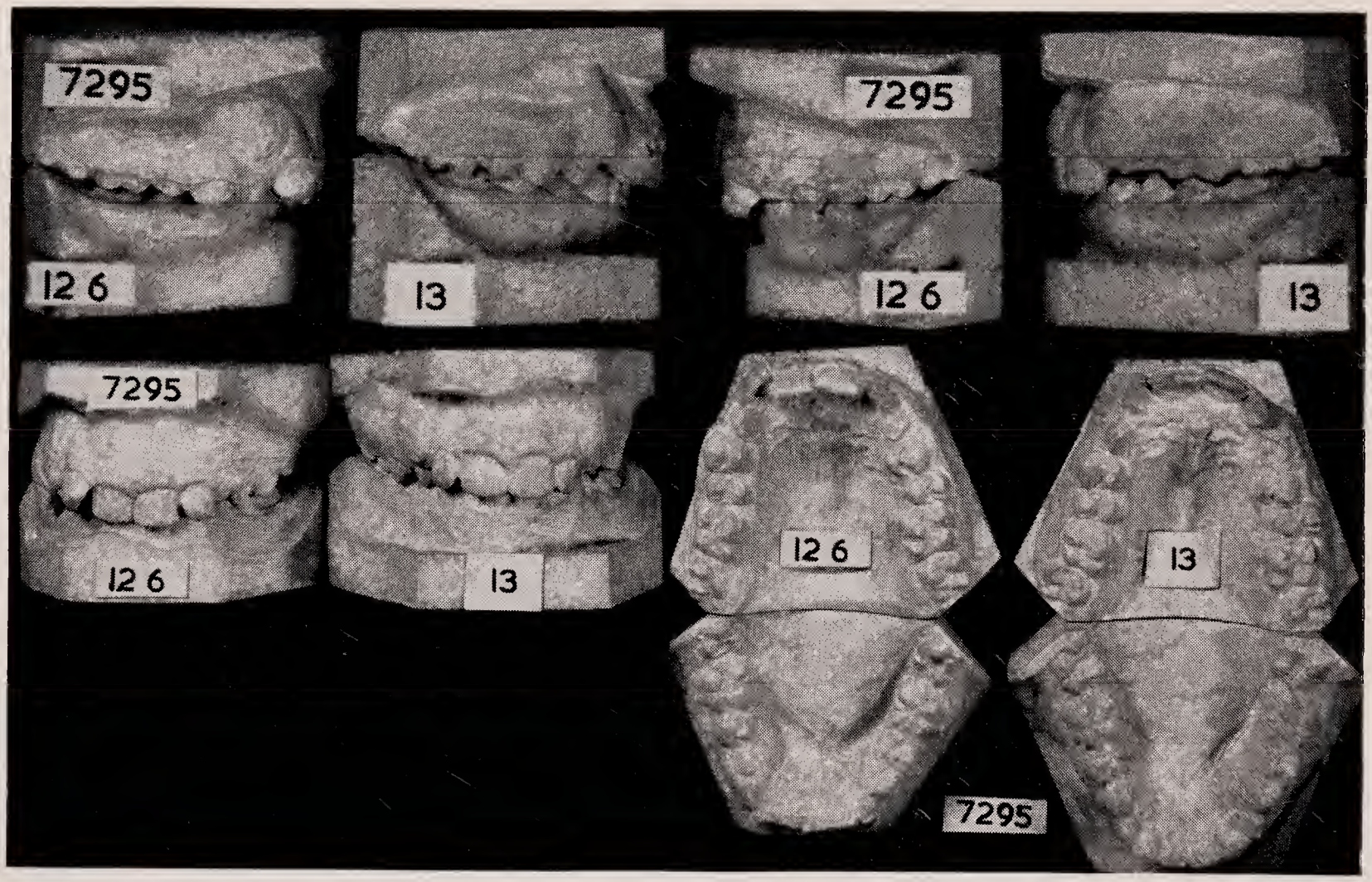
There is no justification for merely changing the form of the malocclusion, and this is what so often occurs with the extraction of first premolars when there is no correction of the excessive overbite and concomitant mandibular displacement, excessive spacing, tilting, and poor contacts.

There are questions which remain unanswered. 'How does the condition arise?',

'Why has it not corrected spontaneously?', or 'Why does it not relapse?' These questions cannot yet be answered, and if the answer is known in one patient it does not necessarily follow that it is the answer in all similar conditions. Dr. Russell Logan's (1962) opinion



A



B

Fig. 6.—In addition to the change in incisal angle, there is also a change in dental base relationship. Both tracings, in this case, are in occlusion and are superimposed on the nasion and SN plane.

that 'Deckbiss' is responsible may be correct, at least to some extent, but again it is not the complete answer. The behaviour of the lips may be a factor in producing the retroclination of the upper central incisors. This is the most common opinion and, if so, then it is not continuous or fixed in type and degree of force or influence on the dental structures (Ballard, 1953, 1956).

A statistical analysis is avoided here, because, taken in this context, it may be grossly misleading, whether or not it appeared to favour this particular type of treatment.

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DISCUSSION

Dr. W. J. Tulley said that he could not understand how Mr. Wilson could make the statements he had from study of the models alone. He could not really see how Mr. Wilson had failed to miss the fact that very few Class II, division 2's had a true mandibular distal displacement.

It was necessary to live with a Class II, division 2 malocclusion to realize that they postured forward in most cases, and that they had to posture forward in speech.

Mr. Luffingham (and many others here) were struggling with methods of measuring resting lip pressures. In 100 students examined, 10 of them had a Class II, division 2 type of malocclusion; 50 per cent of these exhibited increased activity of the lower lip, particularly in speech, but the other 50 per cent showed activity below the mean.

Dr. Tulley said that taking the functional aspect, he did not think that deep overbite *per se* was a reason for early periodontal disease. A number of senior members of the Society had very deep overbites and still had healthy supporting tissues to their teeth. The trouble only came when there was trauma to the soft tissues.

Dr. Tulley showed one very severe case with electromyographic records, and it could be seen how active that lower lip was in speech. The interesting point was that there was a spasm that went on after the man stopped speaking, and in chewing and swallowing the lower lip was very active. This marked activity was found in a proportion of Class II, division 2 malocclusions, and not enough had been done yet to get any real evidence.

Lastly, he wished to comment on Mr. Wilson's question of extraction therapy in Class II, division 2. Most members would agree with Mr. Wilson that there must be extraction somewhere in the upper arch. The cases that Mr. Wilson showed were still crowded and did not look stable. He believed that it was not a good thing to extract too near the front of the arch in most of these cases; but he would defend to the last ditch the need to extract somewhere in the upper arch, whatever the form of treatment proposed.

Mr. G. A. James said he knew that Mr. Wilson was kite-flying, trying deliberately to be provocative, but he could not see that providing a rapid series of bits of cases really made up a paper to a scientific professional society.

Mr. Wilson had made many remarks about statistics and he quite agreed with him that some of them were valid, and he stood corrected on several points, but at least he had made an honest attempt to get at common factors. Mr. Wilson had skated rapidly over some unsupported statements. He had been interested in some of his comments, but did not think they made a basis for discussion when presented in this way.

Mr. H. G. Watkin said that he had been very interested in the discussions. He had been treating Class II, division 2 for about twenty-five years on these lines.

There was one point that had not been brought out quite clearly. It was that the biting of the patient was most important. The mandible was held back by the retroclined upper incisors, and that lock to the mandible was removed by moving the incisors forward, thus making the mandible able to move forward. One taught the patient to move the mandible forward, giving him biting exercises, so that the inclined planes were in Class I relationship but the condyle had moved forward, and the biting effect then moved the lower teeth in the alveolar process. One had a Class I relationship. That was why it was permanent.

Mr. C. D. Parker said that Mr. Wilson showed a case where both the upper and lower incisors had been moved forward a small amount and had remained stable. He believed that this was the type of case where the incisors had only just failed to produce an incisal contact and if they were moved forward to establish contact, vertical improvement and adjustment of the occlusion occurred spontaneously without any further treatment.

Mr. A. C. Campbell quoted Mr. Wilson as saying that he did not understand why there should be a Class II, division 2 and a posture forward, and he mentioned that he could see this in Class II, division 1—trying to masticate and so on.

Mr. Campbell said that subjectively he was only too aware why Class II, division 2 types postured forward. He knew very well that if he did not posture forward he got really quite sore places on the inside of the upper part of his lower lip. He either had to posture forward to get over that or go into occlusion, and this had only become apparent in the last three or four years, when he supposed he must have been going into occlusion and grinding for a long time. He had razor-sharp upper incisors. This situation might well have been present for a long period of time and he would have thought this was quite sufficient stimulus to induce a forward posture.

Mr. A. F. Dee-Shapland said that he was very interested in the paper, particularly as some years ago he had had a lengthy argument with the Dental Estimates Board over the possibility of proclining slightly the upper incisors and reducing the deep overbite. He eventually accomplished the result he desired in this case, and subsequent to treatment he had seen the patient over the last three or four years, and that deep overbite had even been reduced further—possibly (one assumed from today's paper) by the action of the lower lip.

Mr. A. J. Walpole-Day said that no one had described the type of individual who had a Class II, division 2 occlusion. They were, generally speaking, people who were inclined to be a little bit tense and whose muscles were perhaps a little bit more contracted than the average relaxed individual's. Children normally rested with their lips apart, as was well known. This was quite a common feature of a young child. In the case of a young child with Class II, division 2 occlusion the lips were sealed together pretty tightly and the lower lip was pushed up to a certain extent.

He endorsed Dr. Tulley's remarks and also those of Mr. Campbell. Having lived with a Class II, division 2 occlusion and razor-sharp incisor edges, he could confirm the posturing forward in the rest position.

Mr. A. M. Kettle said that he had always considered that there were two kinds of treatment for Class II, division 2; firstly, a treatment which was initiated immediately after the eruption of the incisors, and that was the treatment he had always preferred, because he always finished up with perfectly upright upper incisors, and there was always a diminished incisor overlap.

The second group was the type in which treatment was initiated later on and was invariably accompanied by the extraction of two upper premolars, and that group almost invariably carried with it retroclination of the upper incisors in the finished result.

The other characteristic that was almost invariably present in this malocclusion was the lower mandibular plane angle, and as far as he could remember that had not been mentioned this morning. But the low angle was also associated with a deep incisor overlap. Whether this occurred in a Class I, Class II, or Class III malocclusion, there would always be the deep incisor overlap. That was another reason why they invariably finished up with a deep overlap after treatment. This was a morphological thing which could not be changed.

He was not terribly happy with Mr. Wilson's explanation of what happened, although strangely enough the type of appliance that he described was closely related to the appliance he himself used in these early cases. Although Mr. Wilson was obviously treating them to some extent along the same lines, he was doing it at a later stage.

Mr. H. L. Leech said that a lot had been said this morning about the incisor overbite in Class II, division 2 cases and whether it would remain stable or not. He showed some slides to illustrate what had happened to an incisor overbite quite some time after the end of treatment, the overbite having fully re-established itself.

Mr. C. G. Dickson then showed a number of slides. The first was a case treated by Mr. J. Hooper in 1955, in the mixed dentition, and he was showing it at his suggestion.

He showed slides of a typical Class II, division 2 case before and after treatment by labial movement of the central incisors followed by correction of the buccal segment relationship by intermaxillary traction. Mr. Hooper reported that there was no relapse after one year. About a week ago the boy had moved into his own area and came to him for treatment, but he had not remembered that the Country Meeting was imminent and had not taken models. He could not therefore show the relapse, but could only describe it. Mr. Hooper had treated a number of these cases at this period in this way at this time and they all apparently relapsed similarly.

The form of the relapse was that the buccal segment relationship remained normal and the labial segments relapsed. This was pretty well universal. When the boy came to see Mr. Dickson one lower incisor was extruded almost entirely from the arch, and the upper laterals were forward again. This seemed to be a very common long-term form of relapse. Class II, division 2's treated like this seemed to remain stable for about a year, and five or six years later they relapsed.

Mr. H. E. Wilson (in reply), referring to Dr. Tulley's remarks, said that he did not speak about factors that might have produced the condition he illustrated. All he showed was a tracing of a very deep overbite in an adult which could have been due to any one of a dozen factors. It was not necessarily a true Class II case at all. It should, therefore, be discounted and forgotten.

There was, in fact, a downright difference of opinion. He, as a result of his experience, believed one thing, and Dr. Tulley, as a result of his experience, believed another. They just had to go their separate ways.

What he had tried to do was to give general advice to a mixed group of people, which was that one could not expect to differentiate between types of Class II, division 2 unless it was possible to spend time on doing it. It was necessary to examine the patient carefully and not merely to look at the occlusion and say, 'This is a Class II, division 2, therefore, the treatment is . . .' He still maintained that if extractions were necessary, they were not necessary in the premolar region.

Mr. James was fortunate. He (Mr. Wilson) had to work for his living and spent most of his time in practice; cephalometric X-rays were not taken in practice, and most of the material shown today had come out of the practice. Perhaps he had been 'kite-flying', as Mr. James suggested. He had wanted to get one point across and probably had done so to most of the listeners.

Mr. Campbell asked about the proportion of cases. He was unable to answer his question. He thought, however, that there was a high proportion, certainly more than 50 per cent, which disagreed with what Dr. Tulley (who thought there were few) had said.

In answer to Mr. Kettle, Mr. Wilson said he treated cases when he saw them, i.e., at any time after the eruption of the upper central incisors. He had had success with adult patients who presented, not because of aesthetics, but usually because of malfunction. Patients did not relapse when treated in the middle or late teens.

Professor Walther had answered Mr. Kettle to some extent in saying that the Frankfurt mandibular angle in the Norwich people was higher. Mr. Kettle thought that the angle in Class II, division 2 cases was always low.

Mr. Leech was wrong. He (Mr. Wilson) tried to demonstrate that treatment was possible without extraction. He admitted that there was some degree of relapse in some cases, but one should not compare them with cases treated by a different technique: one could not always compare cases treated by different people with the same technique.

Mr. Dickson had presented Mr. Hooper's case and had said that there had always been a relapse with this type of treatment. Mr. Wilson referred to the first case he illustrated which had spacing in both arches. The patient had been discharged about three and a half years ago, so presumably there was still time for complete relapse. Perhaps he was too optimistic, but there were other cases out of treatment for a long time without relapse.

If a change occurred after treatment had been completed it was not necessarily associated with the treatment. It should be remembered that other factors could operate. Untreated Class I cases could show late imbrication of incisors and this could not be associated with any appliance therapy.

There were cases, he was sure, which were stable, but they had not been illustrated because records were even more incomplete than those shown.

A MODIFICATION OF THE WATKIN PIN AND TUBE APPLIANCE

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WHILE it is generally agreed that simplicity of design is to be desired in selecting an appliance, there are some tooth movements for which a simple appliance is inadequate. Of these, multiple rotations and bodily movement of the root are two commonly found examples. For such cases, fixed appliances offer much better control, particularly the multiband appliances, which are favoured for their versatility. There are now several variations which have stemmed from Angle's edgewise arch, a fact which suggests that an ideal has still to be developed. In all of these a springy arch of wire passes around the buccal and labial surfaces of the teeth, which it engages through the medium of brackets attached to the bands. One type of arch, however, survived with very little modification since 1938, when it was described by Joseph E. Johnson; this is the twin wire arch. It has the advantage of being rather simpler than other members of this family of appliances, but there are limitations to the types of tooth movement it can achieve. When first introduced it was offered as a particularly gentle appliance, requiring a minimum number of bands, but possessing the control required for reasonably exact application of force. The use of two wires, one above the other, ensures that there is more flexibility in the horizontal than in the vertical plane, thus discouraging distortion by masticatory forces and still retaining gentleness labiolingually. The force exerted by two strands of 0·25-mm. diameter hard-drawn round stainless-steel wire is, however, still considerable. This is rather more serious than is the case with the edgewise arch, because a relatively loose bracket engagement allows some initial tilting of the teeth. Contrary to normal practice with other appliances, the use of any form of multiband appliance renders it necessary to aline the teeth before correcting arch relationship or mediodistal discrepancies. Since the forces used in the initial stages are generated by the arch itself, it would seem important to make the arch as flexible as possible, so that especially light forces may be used. In the process of alining crowded teeth, it is probable that much of the force is dissipated among the adjacent teeth, so that little damage is caused. However, this buffering of force is not so effective where irregularity is not accompanied by crowding or where extractions have been performed. In these cases the initial force used should not be excessive, being less than that required for correction of arch relationship.

It has seemed a pity that Watkin's (1933) modification of the pin and tube appliance should not have been used more widely. This appliance is in some ways more versatile than the twin wire arch, but, owing to the length of unsupported wire between incisors and molars, has been made in rather a heavy gauge of wire. To overcome this objection, a modification is suggested in which this part of the arch is sheathed in tube, as in the case of the twin wire arch, and a finer wire is used.

The appliance consists of an arch wire of 0·3-mm. hard-drawn round stainless-steel wire bent in the form of alternating loops and coils, the loops being slotted into boxes welded on to the labial surfaces of anterior bands (*Fig.* 1 A). The distal ends of the arch are sheathed in end tubes of 0·5-mm. internal diameter in the same way as is the twin wire arch, by 'wiggling' the wire and drawing it into the tubes. The end tubes in their turn slide freely in 1·0-mm. tubes soldered on to the molar bands. The arch itself, when fabricated, is made to lie flat in one plane, so that it forms a perfect arc when curved around the arch of teeth. The vertical loops allow labiolingual flexibility to the arch without rendering

Presented at the meeting held on 14 October, 1963.

it vulnerable to distortion by vertical forces. In order to compare their stiffness, both twin wire arch and modified Watkin pin and tube arch were mounted on flat perspex to simulate as exactly as possible conditions in the mouth

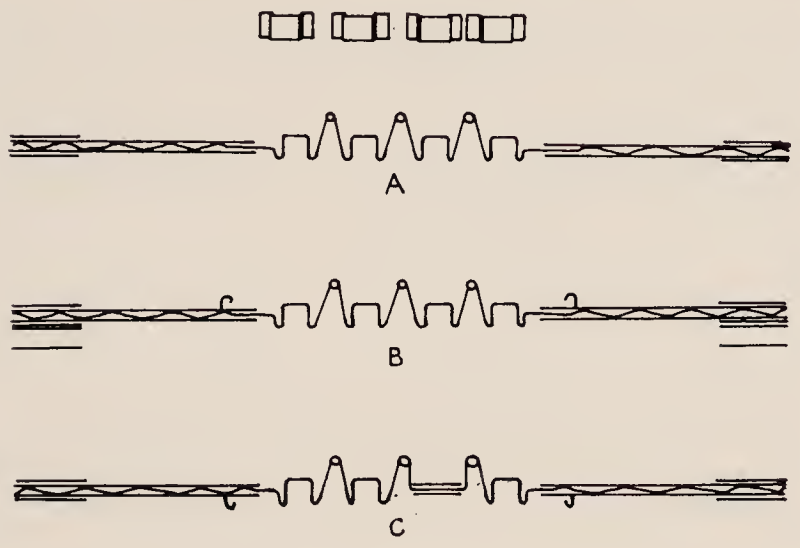


Fig. 1.—Diagrams to show method of construction of modified pin and tube arch for various purposes. A, Plain arch with end tubes. B, Arch with hooks for intramaxillary traction and double tubes for addition of cervical traction. C, Arch with hooks for intermaxillary traction; also incorporated is a spacer.

and its neighbours were extended to 10 cm., displacement at the ends being then divided by 5. It is clear, on examining the table, that the modified Watkin pin and tube appliance is considerably gentler than the twin wire arch.

Table I.—Comparison of the Displacement produced by a Series of Weights on One Bracket in the Case of Twin Wire Arch and Modified Watkin Pin and Tube Arch (*see Fig.* 2)

Weight (force exerted)	Twin Wire Arch	Modified Watkin Pin and Tube Arch
½ oz.	0·1 mm.	0·4 mm.
1 oz.	0·2 mm.	0·6 mm.
2 oz.	0·3 mm.	0·9 mm.
3 oz.	0·4 mm.	1·2 mm.
4 oz.	0·4 mm.	1·5 mm.
6 oz.	0·5 mm.	2·2 mm.

In order to fabricate the arch to an acceptably uniform pattern it is necessary to adapt pliers for this purpose. Two pairs have been found necessary. To form the loops a fine pair

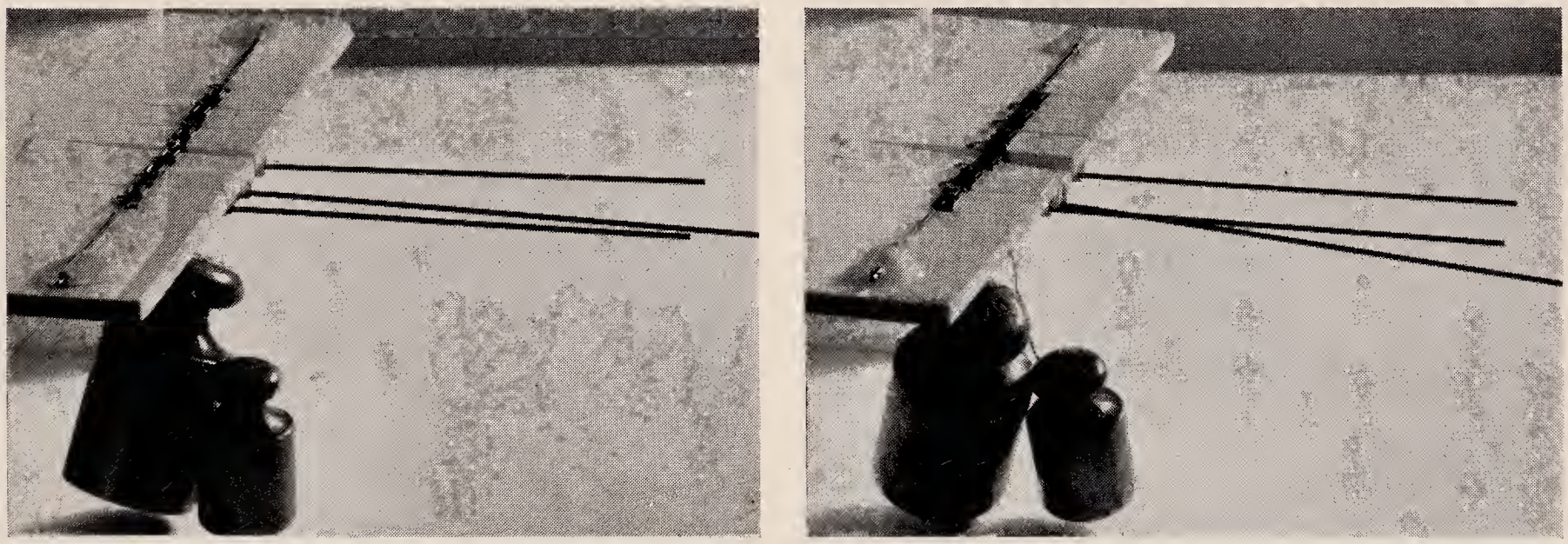


Fig. 2.—Experiment to measure displacement by known loads on: A, Twin wire arch; B, Modified pin and tube arch. (*See Table I.*)

(*Fig.* 2). All dimensions were similar, so that the resistance of each arch to displacement of one bracket could be compared. One bracket was attached to a segment hinged 2 cm. from the bracket to resemble a simple tipping movement. The degree of displacement under tension from a series of known weights is given in *Table I.* In order to facilitate more accurate measurements, the movable segment of snipe-nosed pliers has been adapted so that one beak is of the right width to form the horizontal arm of the loop and the other is of such a width that it contributes correct dimension to the vertical arms (*Fig.* 3). A fine pair of round-nosed pliers is used to form the coils and to make adjustments.

The loops in the arch are fitted into manufactured boxes of the Watkin type. It is

usually necessary to use some means of preventing the escape of the loop from the box. Perhaps the simplest is to push inwards the upper (cervical) margin of the box under the top of the loop. This is made easier by cutting

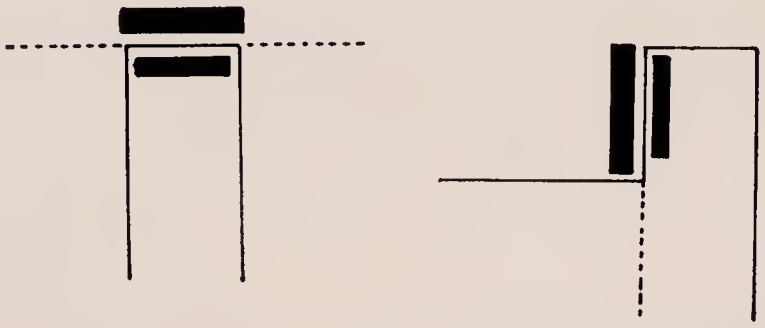


Fig. 3.—Diagrams to show method for bending loops to correct size for fitting into boxes on the bands, using fine snipe-nosed pliers.

one slit in this margin (*Fig.* 4). Cutting two slits permits too much vertical play to the loop by allowing the loop to slide downward over the depressed tongue of tape. In order to remove the arch, the depressed corners of tape may be elevated by inserting the blade of a Cushing scaler into the box.

It might perhaps be of advantage to describe some of the ways in which this appliance is used to achieve various types of tooth movement. Basically, it is similar in its application to the twin wire arch. Where there is crowding of the incisors, their alinement by the appliance causes an increase of arch size, which is usually achieved by labial inclination of the incisors. While this may be desirable in Class III cases, it is usually avoided in Class I and Class II cases by the addition of either intermaxillary elastics or cervical traction. The former may be added by placing hooks on the medial ends of each end tube (*see Fig.* 1 B). There is a

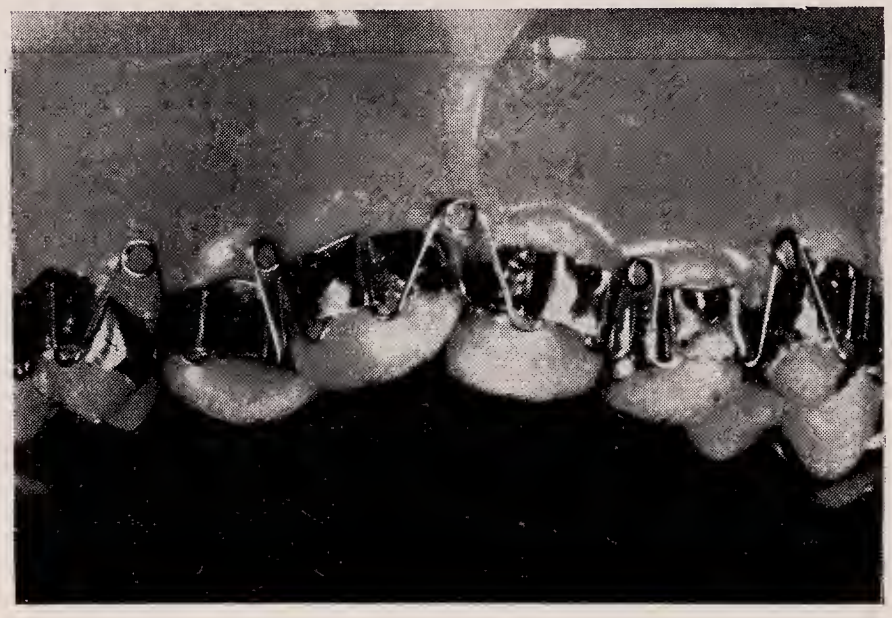
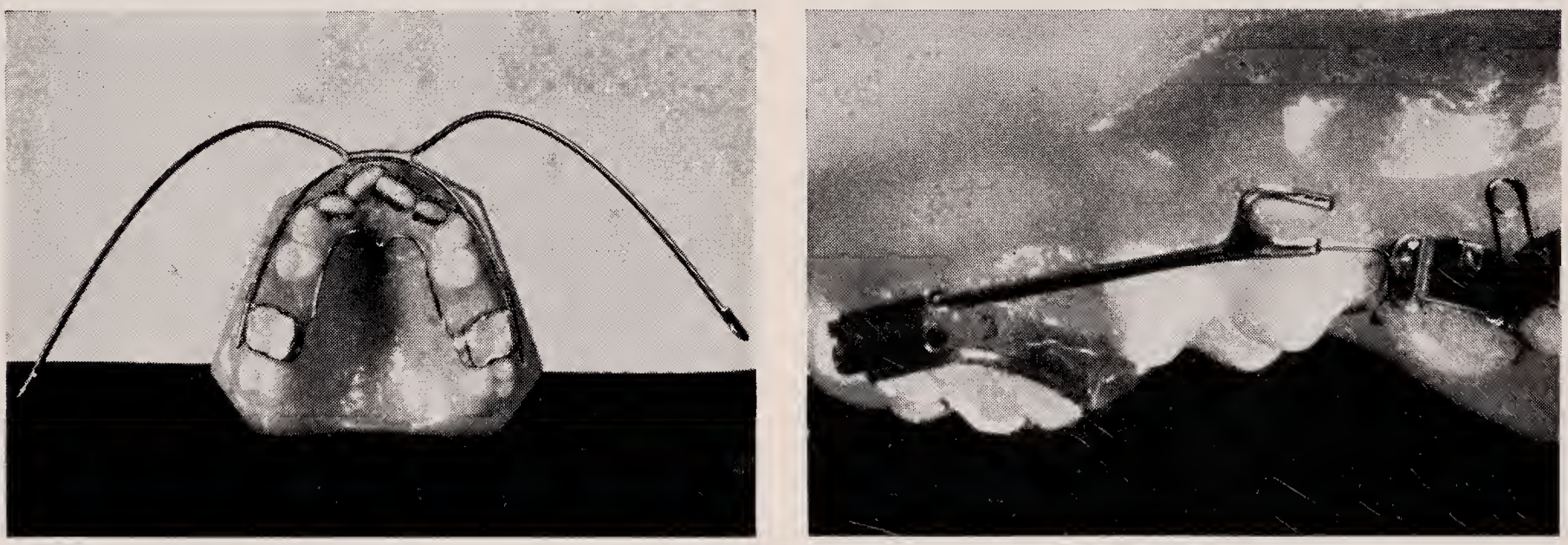


Fig. 4.—Modified pin and tube arch fitted into boxes on the incisor bands. Note slits cut vertically in upper border of each box.

variety of ways in which cervical traction may be added; one that has proved most satisfactory is to solder double tubes to the molar bands, as described by Plint (1961), into the lower of which the extra-oral bow is fitted (*Figs.* 1 B and 5). It is necessary to extend the bow through the molar tubes for the attachment of intramaxillary elastics, which should be lighter than those of the cervical traction. There are anterior hooks for these on the superior (gingival) surface of each end tube.



A B

Fig. 5.—The use of cervical traction with the modified pin and tube appliance. A, Face bow (whiskers) in position. B, Double molar tubes for insertion of the end tube and the face bow. Note intramaxillary hooks on superior surface of the end tube.

Where an incisor is absent from the arch, and it is desired to maintain the space while retracting the remaining incisors, a spacer consisting of a short sleeve of 0·5-mm. tube may be added (*Fig.* 1 C). The use of spacers to protect the arch-wire as it passes along edentulous sections of the dental arch may be of some advantage in cases of partial anodontia. This is a possible solution to problems arising when fixed appliances are necessary for the treatment of cases with very few teeth. Where irregularity is particularly marked it may be necessary to incorporate three coils between attachments. This allows a higher degree of flexibility to the wire and increases its range of activity. As improvement is effected, the arch may be replaced by one with the more simple single loops. A range of adjustments is possible to effect either bodily or tilting movements of the banded teeth in a mediodistal direction. The effect of labial or lingual root torque, however, is less certain, and may require greater forces than have so far been attempted.

Where rotation of incisors is to be effected, it is of advantage to over-rotate the teeth to allow for some subsequent relapse. This can be achieved by rotating the corresponding loops about a vertical axis. Where a single incisor is to be rotated, without any other tooth movement, a local pin and tube appliance is quite adequate. However, it is necessary to band at least the tooth and its two neighbours. This is also sufficient for local tooth movements medially or distally in the lower arch (*Fig.* 6). Bodily movement can be accomplished by maintaining the vertical inclination of the loops and by banding a sufficient number of teeth for anchorage purposes.

Although the fabrication of this arch may appear a little more complicated than that of

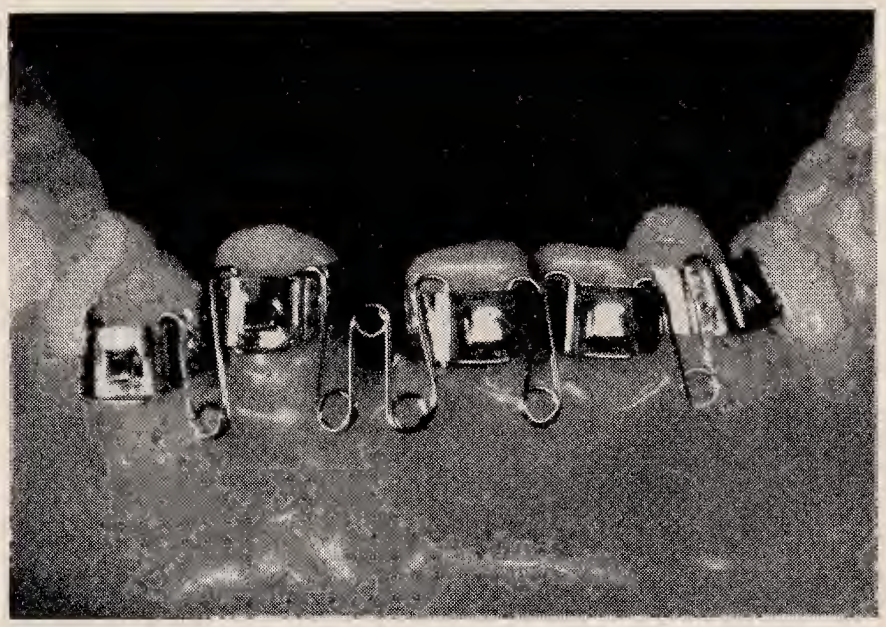


Fig. 6.—Local pin and tube appliance used for purely local tooth movements. Note the triple coil between hands on $\overline{2}|$ and $|\overline{1}$.

the twin wire arch, the repetitive nature of the bending makes it a fairly easy technique to learn. It has the advantage that it may be prepared in advance, since the distance between the medial ends of the end tubes can be varied by opening or closing the coils. It is possible, therefore, to have available a stock of arches which only require shortening of the end tubes before being adapted to a particular case. Because of the ease with which the areh is removed, replacement usually offers no great problems.

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DISCUSSION

Mr. H. G. Watkin asked Mr. Leighton what size wire he had used. He used 0·35-mm. wire.

Mr. Leighton replied that he used 0·3-mm. wire.

Mr. Watkin said that that was strong enough. He asked if loops between the incisors were required and Mr. Leighton replied that they were not. Mr. Watkin then asked about spacing and Mr. Leighton said that, in the particular case being discussed, the lateral erupted some way from the centre and would have to be moved towards the centre. It had seemed the lesser of two evils to keep the lateral the way it was.

Mr. Watkin asked if a denture was used and Mr. Leighton replied that it was. Mr. Watkin then said that he would do anything to prevent a young patient wearing a denture all her life. He had had a case where the two central incisors were knocked out in an aceident and he had brought the laterals together with a pin-and-tube appliance. The laterals were then crowned to resemble centrals.

Mr. F. Allan said that everyone had to deal with rotations in orthodontics. There were, however, two distinct types of rotation. There was rotation due to crowding, and rotation without crowding. A clear distinction should be made. If the crowding was removed, most of these teeth aline themselves as they find their rightful place in the arch. Some of the cases shown were

due to crowding. He asked if such cases were dealt with by extraction first, so that room was created for correction.

He himself had a simple method for rotating teeth once there was room for them. If there was rotation when there was room in the first place, apart from interference from the opposing arch, he had no answer for it where there was no other reason why it was rotated.

If there was room for a rotated tooth, or once room had been made for a rotated tooth that still required correction, he had a much simpler method than the one demonstrated.

The necessary number of teeth were banded and the brackets welded on, both off-set mesiodistally and also, where necessary, at an angle to the long axis of the tooth. Such bands could be preformed and a stock of them made by lay assistants. The effect of 'tip-back bends' could be produced similarly by positioning the brackets and using a straight arch wire.

Mr. M. L. Brenchley asked Mr. Leighton to explain how he drew up the arch.

Mr. J. S. Beresford asked, in the treatment of cases such as Class III's, where Mr. Leighton was correcting rotations and irregularities without having to close up spaces, how many times did he have to remove the arch, adjust it, and put it back?

Mr. E. J. S. Clifford asked if there was any reason why the apices of the loops Mr. Leighton made in the loop and tube appliances were so angular. He would have thought, in a 0·3-mm. wire, that it would be possible to make a more gentle curve. With the angulation used, did Mr. Leighton get many fractures?

Mr. Watkin said that he did not think one cut in the tube was sufficient when getting the loops out. He thought two were better. With one cut, one bent the corners in and it was difficult to straighten them out. The band would probably loosen in the attempt.

Mr. Leighton replied that it still remained for him to experience that.

Mr. Leighton, replying to the discussion, said that he was in entire agreement with Mr. Allan; there was really nothing left for him to say.

In reply to Mr. Brenchley, he said that the arch was drawn into the tubes the 'wrong' way. The distal end of the arch was pushed through the tubes, and with two pairs of pliers, one pushing on the tube and one seizing the arch, it was forced or drawn in. Unlike the twin wire arch, it was not drawn from within outwards, but from without inwards.

To Mr. Beresford, he said that the arch was easy to remove. It was, in fact, removed each time the patient was inspected, which was about every three or four weeks. Minor adjustments were made nearly every time. The alinement of teeth, provided there were no complications, could be achieved in a fairly short time, perhaps three or four months.

Occasionally, with a very irregular arch, it might be necessary to make a new arch.

Mr. Clifford had asked about the corners of the loops. The reason was that if rounded loops were made, it was rather more difficult to make them exactly the right width to fit the box. This was rather important. The loops should really fit the box quite accurately in order to keep better control of the teeth. The wire, thin as it was, really did engage the bracket on the teeth. It was not there that it got broken, but where it emerged from the box and turned up into the coil between the teeth, or where it emerged from the tube.

NUTRITION AND GROWTH

By ALICE M. COPPING, D.SC.
Senior Lecturer in Nutrition, Queen Elizabeth College, University of London

IT is a great honour for a nutritionist to be asked to give the Northcroft Memorial Lecture to the British Society for the Study of Orthodontics. I looked up the meaning of 'orthodontics' and found that it was the study of prevention and correction of irregularities of the teeth and of malocclusion. I can claim no knowledge in this field and I am not even directly concerned with problems of human growth and human nutrition, except in so far as my work of training students may lead to wider dissemination of improved ideas on food and nutrition. In common with most nutritionists of my generation, I began in a purely scientific field and gradually acquired some knowledge of nutrition from reading and research. After many years I was persuaded to teach nutrition, first to dietitians and later as a full degree subject. In the last ten years at Queen Elizabeth College we have been teaching a regular degree course which enables students to graduate with B.Sc. (Nutrition), so that 'self-made' nutritionists will soon cease to be the usual type of nutrition specialists. In 1962 we began a new postgraduate course designed to give nutrition training to graduates in medicine, agriculture, veterinary science, physiology, or allied subjects, and maybe graduates in dentistry will be inspired to come in the future. Our first postgraduate group of 10 students of 8 nationalities was a wonderful example of growth of understanding of language and subject. Our new group of 16 students of 15 nationalities looks like being an equally interesting challenge to our ability to impart ideas on nutrition.

GROWTH OF MICRO-ORGANISMS

From this preamble about my present occupation let me turn to the subject of my lecture, with emphasis first on the matter of growth. The *Concise Oxford English Dictionary* defines growth as 'development' or 'increase'. My scientific interest in growth began when I moved from organic chemical research to biochemical research and found myself faced with the problem of untangling the bios requirements of yeasts. In 1927, when the work was started, little was known of the nature of bios beyond the description given by Wildiers, in 1901, of an organic growth stimulant required by yeast cells in a purified medium. With the unfolding knowledge of the vitamins of the B complex, the nature of the several components of the original bios has been defined. All the components are now recognized growth factors, not only for micro-organisms but also for higher animals. It was highly instructive to begin studying growth with micro-organisms where it was possible to measure increase in cell populations and also metabolic activity of cells in relation to the presence or absence of a growth-stimulating factor. In all, twenty different yeasts were studied and some of the so-called wild yeasts of the *Willia* and *Mycoderma* species were able to produce bios in a synthetic medium. Other species required addition of bios before cell multiplication could occur in the same synthetic medium. A study of the relation of the bios requirement to aerobic and anaerobic fermentation provided much useful information on the metabolic functions of the cell in the process of multiplication. The actual need of yeast cells for bios in growth and metabolism was dependent on the type of yeast and on the composition of the medium (Copping, 1929).

In later years, specific nutrient requirements of micro-organisms have been utilized as a means of assaying vitamin and amino-acid contents of foods and tissues. Microbiological methods of assay now rank above biological or chemical methods in many fields. Bacterial

The seventeenth Northcroft Memorial Lecture given at the meeting held on 11 November, 1963.

growth may be measured by viable count, or by dry weight of cells produced under known conditions, or by turbidity or total nitrogen production. From a biological point of view the most important observation is the curve plotted from total cell-count against time. Monod (1942) has shown that typical curves of bacterial cell-counts show eight phases of growth. These are:—

1. An initial stationary phase during which no multiplication occurs.
2. A lag phase or period of positive growth acceleration during which the rate of multiplication increases with time.
3. The logarithmic growth phase during which the rate of increase remains constant.
4. The phase of negative growth acceleration during which the rate of multiplication decreases.
5. The maximum stationary phase during which no change in population occurs.
6. The phase of accelerated death-rate during which the numbers fall off with increasing rapidity.
7. The logarithmic death phase during which the rate of death is constant.
8. The phase of decreasing death-rate.

It is tempting to speculate on the analogy between growth phases in micro-organisms and in animals. There are, indeed, some parallel stages in growth of the mammal from conception to death, but it is more difficult to obtain standard conditions for growth of an animal throughout its whole life-span, so complete comparisons cannot be made. The effect of nutrient variations in media on the phases of growth has led to development of refinements in microbiological assays and has provided much valuable information on nutrition in general. The great differences found in nutrient requirements of bacteria often provide clues to nutrient provision for higher organisms. Microbiological studies have been particularly important in research on the vitamin B complex and have supplemented the biological work in the field where animal growth has often been used as the measure of requirement. For instance, the crucial test of the liver factor vitamin B_{12} was made with micro-organisms.

GROWTH OF ANIMALS

After my initial training in the nature of growth at the cellular level, I found myself transferred to research with rats as experimental animals in studies of vitamins. In many investigations growth in terms of increase in body-weight was the criterion chosen for assessing response to new or known vitamins or to diets of varied composition. The rat has proved itself an admirable laboratory animal for nutritional research, and with rats from a colony of known dietary and genetic history it is possible to obtain consistent responses in weight increase to given stimuli. For instance, in an experiment carried out in 1943 and in another in 1954, the average weekly gain in weight of groups of rats given graded doses of pyridoxine were almost identical (Batchen, Cheesman, Copping, and Trusler, 1955). This well-controlled growth response was obtained from a colony of laboratory-bred rats which had been maintained completely inbred for thirty-five years.

THE NATURE OF THE GROWTH PROCESS

After many years of using growth as a means of testing response to nutrients I became more interested in the nature of the growth process itself. This arose from the problem of designing a complete purified diet for rats at a time when the possibility existed of having most essential nutrients available in pure form. Early experimental diets had always, of necessity, contained liver extracts, or yeast extracts, or dried yeast, or other natural products as sources of vitamins, and it was only when all known vitamins could be obtained as pure substances at reasonable cost that purified diets could be adequately controlled. It was then of prime importance to find out whether a growth response equivalent to that on a complete natural diet would occur on a purified diet. This observation entailed knowledge of the optimal growth-rate of the strain of animals used in the experiments.

Donaldson (1924), in his classical treatise on the rat, stressed the need for standardization of performance in growth studies. He

showed also the need for correlation of old and new data on growth and physiological performance. A most useful review by Dunn, Murphy, and Rockland (1947) further emphasized the need for correlation of data and for full investigation of experimental conditions affecting the performance of animals for which growth results are collected. Incomplete information on nutrition and husbandry frequently invalidates results. It is probable that the growth curves set out by Donaldson were based on studies in which the diets were inadequately described and were likely to be deficient in some essential nutrients. This was pointed out by Zucker, Hall, Young, and Zucker (1941a) in their review of animal growth and nutrition, with special reference to the rat. The experimental methods and diets used by Zucker and others (1941b) allowed them to suggest an empirical formula for growth and also to indicate possible deviations from the normal curve when diets of suboptimal nutrient content were used. They observed that the growth of rats on good stock diets was characterized by a progressive decrease in weight gain for each measured time-interval after weaning. The growth from weaning could conveniently be plotted as a straight line if the logarithm of the weight and the reciprocal of the time were used as coordinates. The formula for the line is $\log W = -k/t + \log A$ where W is weight at time t, A is the maximum weight approached asymptotically in the adult animal, $\log A$ the intercept of the straight line, and k the slope of the line. The value for k is obtained from the formula

$$k = \frac{\log W_2 - \log W_2}{1/t_1 - 1/t_2}.$$

Zucker and his colleagues applied these formulae to data from their own rat colony and from other colonies, and from their calculations observed that the value for k was characteristic of a colony. The slopes of lines drawn for females were always flatter than those for males, and k values for females tended to be more variable but in a fairly constant relationship to those of males of the same colony. In 1943 Zucker and Zueker showed that any departure from the straight line expressed by $\log W = -k/t + \log A$ was an indication of inadequacy in the diet and that typical aberrations could be attributed to specific nutrient deficiencies. Their findings were used to show the different nutritive value of meals prepared from cottonseeds, peas, and soya beans given as supplements to diets based on white flour. The efficiency of the three meals as sources of B vitamins and protein was determined from the growth curves, and it appeared that a mixture of all three meals might be able to replace meat as a source of protein and B vitamins.

Gray and Addis (1948) compared the slopes of lines obtained with Zucker's formula in 9 different rat colonies and showed that though straight lines were obtained when diets were satisfactory the slope of the line and the $\log A$ intercept varied considerably. They suggested the application of Zucker's formula as a routine method of testing for the operation, on a colony, of unsuspected variable factors. An illustration of this application is provided by studies of the growth of black and white Lister stock rats at the Lister Institute in 1947–8 and again in 1952, three years after the transfer of the colony to Queen Elizabeth College. The curves for weight increase of males on the normal stock diet were very similar and the straight lines obtained from the $\log W$/reciprocal T plot showed similar slopes and values for k and for final weight attainable. Studies of growth on experimental diets (Copping, Crowe, and Pond, 1951) showed that the protein content of the diet was critical in permitting normal growth and that growth performance was dependent also on the B-vitamin supply.

This is illustrated in *Fig.* 1, where curves of weight increase plotted against time are shown for rats having a normal stock diet (Group H) or purified diets with the protein as casein from different preparations and synthetic vitamin supplements. Groups B, D, and G had liver extracts in addition to their synthetic B-vitamins, and it is of interest that all groups except those on the stock diet fall very closely together. Moreover, in *Fig.* 2, where the logarithm of the

weight is plotted against the reciprocal of the time, the good straight lines obtained for all the groups of rats indicate the essentially satisfactory composition of all the diets.

EFFECT OF RATE OF GROWTH ON BODY COMPOSITION

Recent observations of Widdowson and McCance (1960) on the effect of rate of growth on the composition of young rats and upon their physiological development showed that some features were little affected by the plane of nutrition during suckling. The alteration in plane of nutrition was achieved quite simply by varying the number of rats suckled by a mother from 3 to 15 or 20, so that the young from small litters were as much as four times heavier than those from large litters. It was observed in all rats that the eyes opened and the teeth erupted at the normal chronological age, but the onset of puberty and the instinctive desire to explore new surroundings were developed earlier in rats having growth accelerated by a high plane of nutrition. It seemed that attainment of a definite weight in the rat was linked with sexual development and with exploration activities. When growth-rate was checked by lowering the plane of nutrition from the ninth to the twelfth week of life the lost weight was rapidly regained when unlimited food was given. It was, however, observed that undernutrition during suckling,

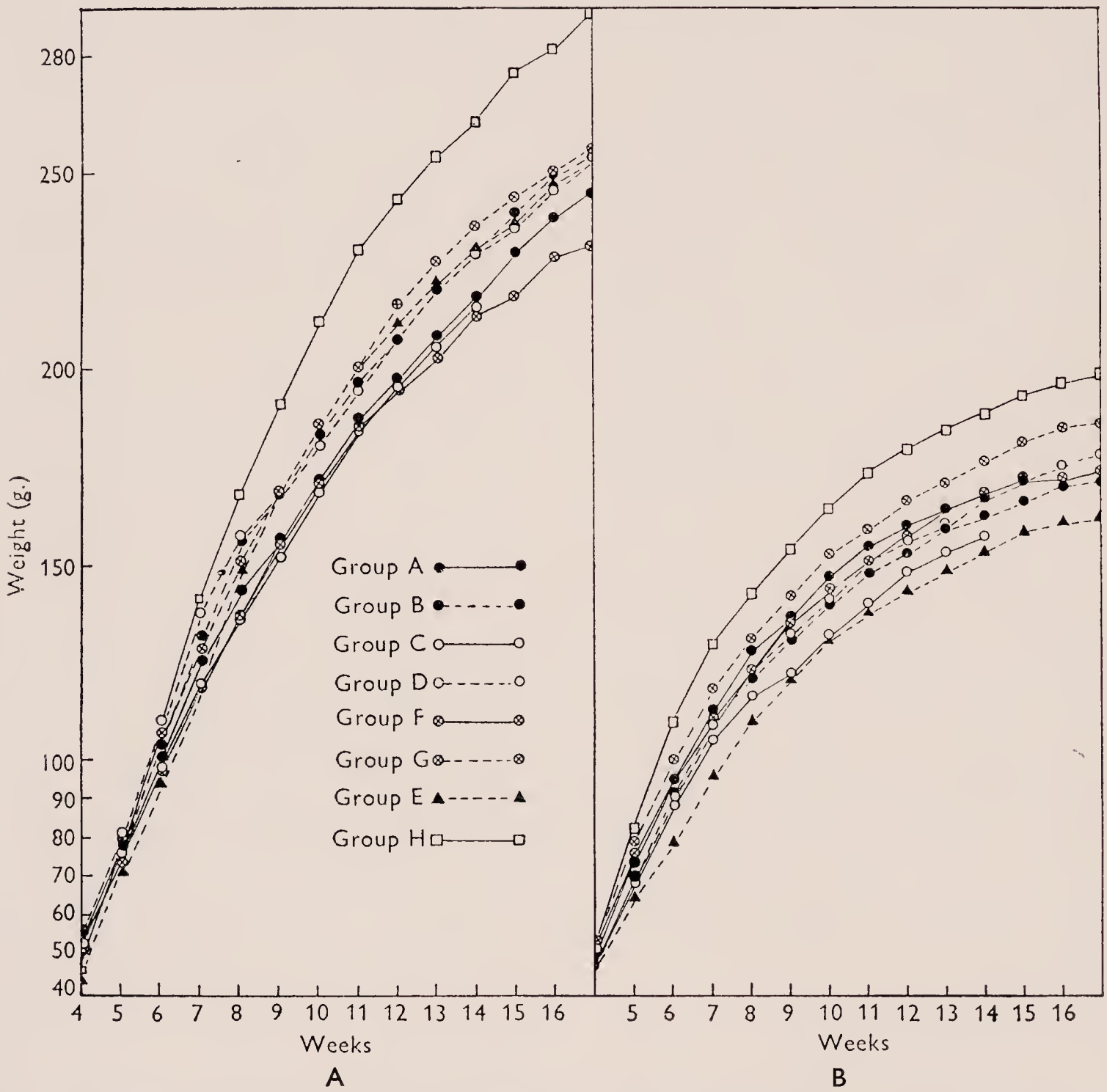


Fig. 1.—Curves showing the relation between age in weeks and mean body-weight in grammes of (A) male rats and (B) female rats on various diets.

which produced lower weights at weaning, prevented these small rats from catching up with normally fed or overfed animals in later life.

Dickerson and Widdowson (1960) investigated the effects of accelerated growth on skeletal development, and showed that the normal relation between bone age and chronological age was disturbed and the skeleton in rapidly growing young rats was not able to mature quite fast enough to keep pace with the increase in weight. Thus younger rats of the same weight as slower growing rats of greater age had less advanced epiphysial development and their femora were shorter and contained less calcium. The effects obtained by varied nutrition in suckling rats, which are born in an extremely immature state, may be produced in other animals before birth. Wallace (1948) found that ewes on a high plane of nutrition during pregnancy produced large lambs with larger skeletons than those of small lambs from ewes on a low plane of nutrition. The production of animals of desirable carcass formation for the meat trade is now approached by growers of lamb, beef, pork, and bacon from the angle of control of nutrition as well as control of breed and general conditions of husbandry. Widdowson and McCance (1960) showed that the muscles of rats in their accelerated growth groups were large in size but immature in composition. This correlation between growth and nutrition is also of importance in meat production, where rapid achievement of required weight can produce tender meat.

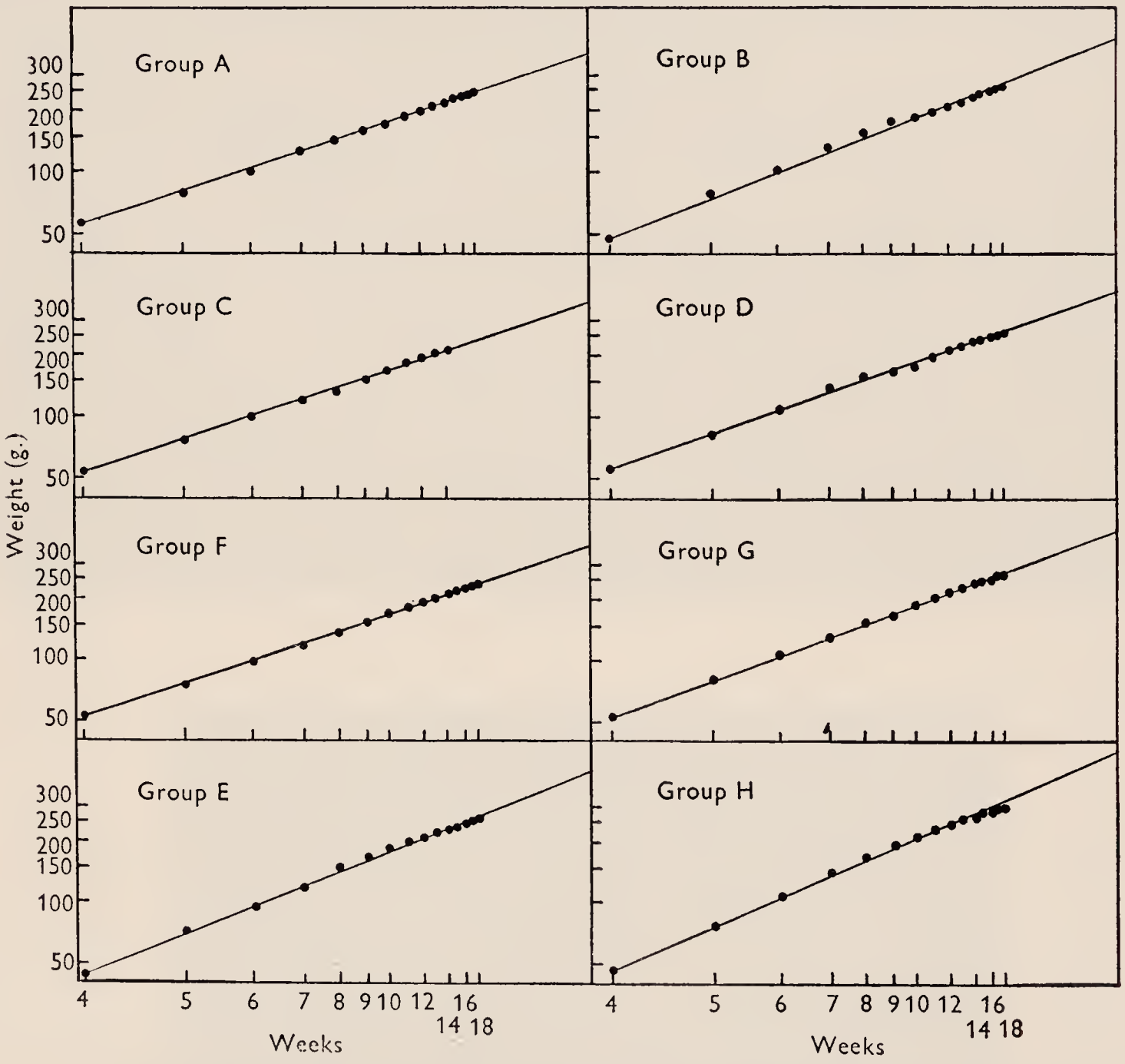
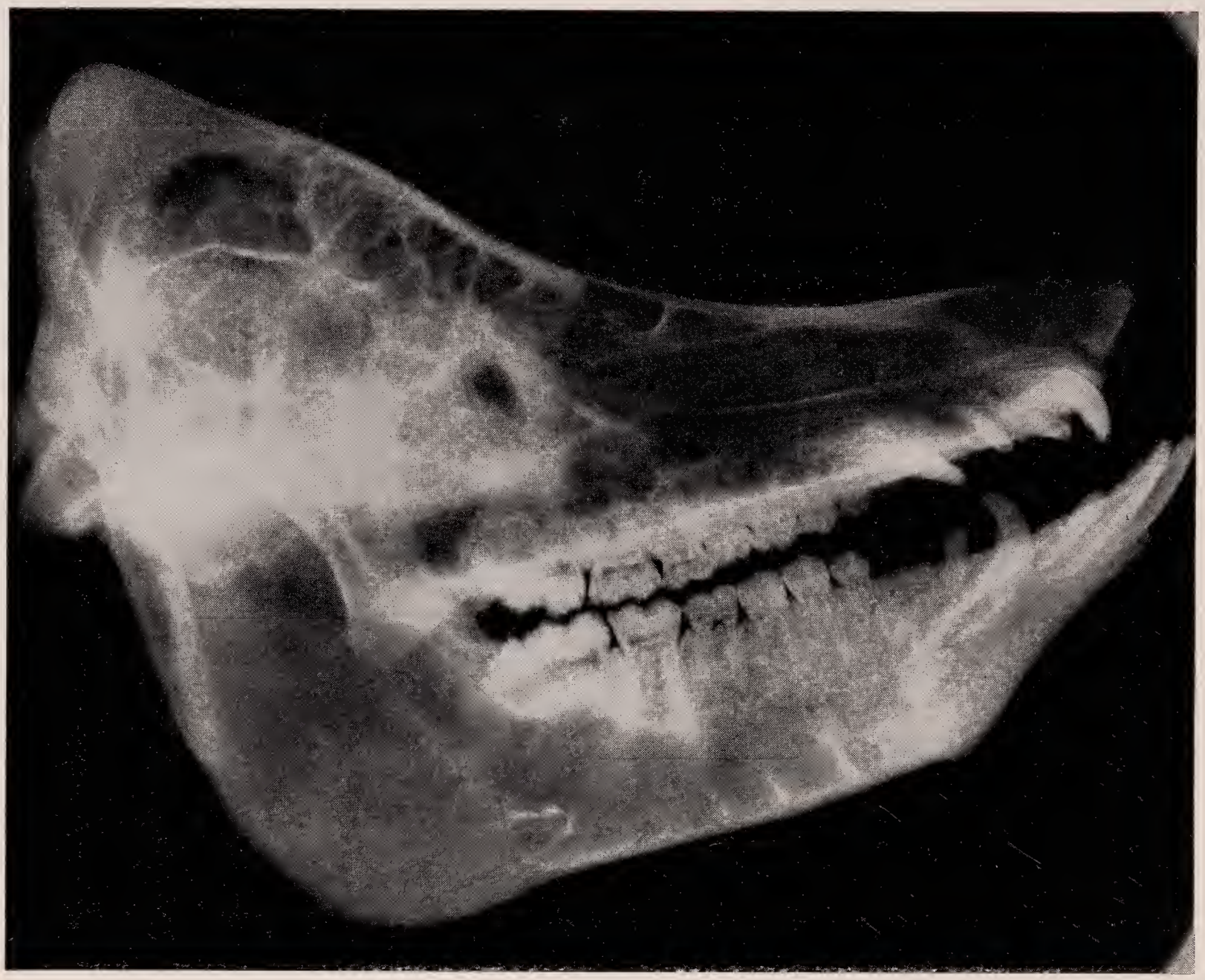


Fig. 2.—Curves showing the relation between the reciprocal of the age in weeks and the logarithm of the mean body-weight in grammes of male rats on various diets.



A

B

Fig. 3.—A, Skull of a normal pig aged 13 months; B, Skull of an undernourished animal aged 15 months (same scale as A) to show how undernutrition interfered with the position, growth, and normal occlusion of the teeth. It also shows that the surfaces of the deciduous and permanent teeth in the undernourished animal were being rapidly worn away. (*Reproduced by kind permission of the* '*British Journal of Nutrition*', 1961, **15**, 223.)

EFFECT OF UNDERNUTRITION ON JAWS AND TEETH

Curious effects of prolonged undernutrition on skull, jaws, and teeth have been described in pigs (McCance, Ford, and Brown, 1961) when by simple restriction of food intake young pigs were kept at low weights for 3 to 15 months. Comparisons were made with pigs having the same diet in unlimited amounts and with animals which had been undernourished for 1 to 2 years and then rehabilitated (*Fig.* 3). The pigs on restricted food intake were small in weight and stature and had heads large in proportion to their bodies. The growth of the jaw was more severely retarded than the development of the teeth. The mandible was less affected than the maxilla and the incisors erupted at an abnormal angle. The crowns of the teeth were usually of normal size so that crowding of all teeth occurred and the molars were impacted. Undernutrition delayed calcification and interfered with normal occlusion. This led to extensive and irregular wear of the oeclusal surfaces in both temporary and permanent teeth. Although there were abnormalitics of jaws and teeth the size of the endocranial cavity was little affected by the undernutrition, but the bones were very thin. Rehabilitation restored the proportions of skull and jaws to normal, but left most of the abnormalities of the teeth unchanged.

GROWTH OF CHILDREN

In his initial paper on effects of severe undernutrition in growing and adult animals McCance (1960) states that his experimental work was the outcome of observations made in the years immediately following the Second World War. Widdowson and McCance (1954), in their report on the growth of undernourished children in two orphanages in Germany, provide much valuable information on the effects of rehabilitation after prolonged undernutrition of children aged 3 to 15 years. The study of these children was planned as a means of testing the nutritive value of bread and the effect of the extraction rate of flour. In the final assessment, the results of growth showed no significant differences between the nutritive values of flours of 70, 85, or 100 per cent extraction, but the supplementation of the orphanage diets with bread available in unlimited amounts caused a rapid increase in height and weight of both boys and girls during the year of experiment. The actual rates recorded were slightly above an accepted Ameriean standard. The response to refeeding was probably the normal effect of giving sufficient calories after a period of underfeeding, and the growth responses in height and weight were not specifically related to the dietary composition.

The skeletal development of the children was examined at the beginning and at the end of the experimental feeding period. It was found initially in 77 girls and 86 boys, aged 5 to 14 years, that the ossification of the hands and knees and the epiphysial development of the German children was retarded in comparison with British and American children. During the ycar of the extra bread-supply the ossification of the hands and knees inereased by more than the expected increment and the epiphysial development of the bones improved, but did not reach that of British children of the same age. Thc bone changes in the German children were correlated with their increases in height.

The occurrence of dental caries and the structure of deciduous and permanent teeth were investigated also. Teeth of children in one of the orphanages were notably less well formed than those in the other. The increase in caries was low in both orphanages during the experimental feeding period in comparison with the incidence in another orphanage in the same region where the children had only the available rations of the period.

A further study was made, during 6 months on children in one orphanage, of the effect of the addition of a milk supplement to a diet containing unrestricted amounts of bread made from 85 per cent extraction flour. Two groups, each of about 40 boys, and two, each of 40 girls, were carefully matched for age and size and the small quantities of milk available in the ordinary ration were increased for one group of boys and one group of girls by 500 ml. daily. The control groups had a snack, consisting of a drink made up from concentrated

orange juice and biscuits to give a caloric supplement equivalent to the 500 ml. extra milk. The main effect of the milk on the diet composition was a considerable increase in the animal protein intake. Intakes of calories, calcium, and iron were approximately the same for all groups. The average gains in height and weight of boys and girls in the groups having milk or orange juice and biscuits were almost exactly the same. The fact that extra milk, even with its superior animal protein contribution, did not produce an increased growth response in children aged 5 to 15 years was discussed, with reference to the study of Corry Mann (1926). Corry Mann studied the effect on growth of schoolboys aged 6 to 11 years of additions to their ordinary diet of milk, or butter, or margarine, or sugar in approximately equicaloric amounts. Two other groups having casein supplying 16 g. animal protein or fresh watercress were included in the study. The most marked increases in height and weight occurred in the boys having extra milk; the next best increases occurred in those having equicaloric additions of butter. In consideration of the difference in the two sets of observations, Widdowson and McCance (1954) suggest that their milk supplements were given with diets already adequate with regard to calcium and vitamin D, and that it was probable that the schoolboys' diets in Corry Mann's study may not have been well provided with these factors. This suggestion is supported by the relatively good response in height and weight increase in boys having a watercress supplement which would probably be rich in calcium. Corry Mann observed, also among his schoolboys, that during the summer months there was usually a greater weight increment than during the winter months. The summer advantage was correlated with longer time out of doors, which would mean exposure to sunlight or to skyshine. Although he does not specifically record any relation to vitamin D for his growth results, it may be assumed that the vitamin D contributed by synthesis due to exposure to sunlight was a factor in these results.

Vitamin D in its fundamental relation to normal bone structure is a nutritional factor closely associated with growth, especially in the young animal and the human infant. The chief result of vitamin-D deficiency is disruption of the orderly process of bone formation. This leads to the production of an excessive amount of uncalcified osteoid in the long bones, and as the results of stress and strain of movement deformities occur. True rachitic deformities have become very rare in Britain since nutrition of mothers and infants has improved during the past thirty years, but some evidence of rickets is still found in other northern European countries. The requirement of man for vitamin D is still a matter of conjecture, but it is probably closely related to calcium and protein intake. Both calcium and protein are essential requirements for normal growth. A survey was carried out by Van Schaik between 1958 and 1960 (Van Schaik, 1961) in Tilburg, in South Holland, and in Leeuwarden, in North Holland, on 480 children aged 8 years ranking second in a small family or second or fifth in a large family. Children ranking second in a small family were superior in height and weight, and in gains in height and weight, at three intervals of 6 months to those coming second in a large family. The children ranking fifth in a large family were in general poorer in every way than the others examined. Dietary studies showed a lower calcium and protein intake for children in the large families. There were other social, economic, and nutritional factors to be taken into account, and none of the children was seriously undernourished. It remains, nevertheless, an important study from the standpoint of the effect of family size on growth and nutritional condition.

Among the many records of the effect of nutritional status on growth I like to turn to the book on *The Schoolboy: His Nutrition and Development*, by G. E. Friend (1935), who was medical officer of Christ's Hospital, Horsham. He had a grand opportunity of examining successive generations of boys in the school during 20 years from 1913 to 1933. He divides his investigations into four periods:—

A, Winter term, 1913–Summer term, 1916
B, Winter term, 1916–Summer term, 1922
C, Winter term, 1922–Summer term, 1927
D, Winter term, 1927–Summer term, 1933.

In the first period the diet became increasingly unsatisfactory under the rationing conditions of the First World War, and in the second period restrictions were still present, especially in supplies of meat, butter, and milk. The third period covered a return to more normal conditions, and the fourth period was characterized by a comparatively high average caloric intake of 3000 Cal., with good protein and fat supplies. Over the whole 20 years there was a continuous upward trend in height and weight, with slight setbacks in 1917–19.

This upward trend in height and weight of boys in one school community is reflected in more recent reports of Daley (1944, 1948, 1950) on increases in heights and weights of London schoolchildren. In the 1950 report a striking feature of the averages over the previous 10 years was that the change in weight was in proportion to the change in height, so that ratio of height to weight in all age-groups remained almost unchanged. In 1954 Boyne and Leitch reviewed secular change in the height of British adults, and concluded that the available information was inadequate to show by comparison of records whether or not the maximum stature of the population had increased over the past 100 years. The relation of attainment of maximum height to changing social conditions was discussed in Britain, Denmark, and Sweden. A further review by Boyne, Aitken, and Leitch (1957) is concerned with secular change in height and weight of British children, including an analysis of measurements of English children in primary schools from 1911 to 1953. In this study the rising trend in height and weight for both boys and girls at ages 5, 8, and 12 years showed in all the records examined, with an acceleration of the increases from 1945. The authors do not discuss the effects of nutrition so much as those of environment. It is, however, worthy of note that family diets have improved since 1945 in comparison with prewar diets (Baines, Hollingsworth, and Leitch, 1963) and that it is therefore probable that increases in height and weight of children are related to improvement in their nutritional standards. The review by Baines and others (1963) also agrees with the observation of Van Schaik (1961) in finding that the supplies of essential nutrients were poorest in the largest families. This was the case even though most post-war families were able to carry a food budget large enough to provide a satisfactory diet.

As information from other countries becomes available increases in stature appear to be found in many young populations. Mitchell (1961) drew attention to the fact that in Japan increments of increase in stature in recent years were greater than those reported for other countries. She attributed this to the improved nutrition of Japanese children since 1945. A further report on children in 22 orphanages in Hokkaido (Mitchell and Santo, 1962) showed that where the food patterns indicated a limited protein intake the children were shorter than the national average. Mitchell (1963) has correlated further studies on Japanese and American children and considers that a close relation exists between nutrition and growth.

CONCLUSION

In conclusion, it is worth recalling the wise observation of Atwater and Benedict (1898–1900) in connexion with the problem of caloric and protein standards. They stressed the fact that man can adjust his energy expenditure so as to maintain physiological equilibrium on a high or a low level. They pointed out that the higher level could be as much as twice the lower level. It is therefore advisable to consider nutritional requirements in relation to a basic type and to adjust standards according to weight, age, environmental temperature, and other factors. Whether we are to consider growth in weight or growth in bone length as the absolute criterion of good nutrition is at present a matter of controversy, and the weight to height relation is a most important factor. It is probable that correction for weight is fundamental, and not the least problem is what is the most desirable weight. Beauty is in the eye of the beholder, and, though many Indian or Japanese people may appear underweight and many West Africans overweight, to a European observer their ideals of growth

and form suit their own requirements. We cannot fit all mankind into the same mould nor can we lay down absolute standards of nutrition to produce the optimum growth for all nations. We can only do our best to assure satisfactory nutritional conditions, and growth performance is a yardstick of such conditions.

Acknowledgement.—My thanks are due to Professor R. A. McCance and his colleagues, of the Department of Experimental Medicine, University of Cambridge, for permission to reproduce *Fig.* 3.

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ORTHODONTIC TREATMENT FOLLOWING OPENING OF A DENTIGEROUS CYST

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INTRODUCTION

DENTIGEROUS cysts of the jaws are known to occur in the very young. The youngest patient on record is that of Bernick (1949), who described the condition in a child aged 22 months. Stones (1962) quotes instances occurring from the age of 6 years. The following report concerns the surgical treatment of a dentigerous cyst, followed by orthodontic treatment, in a young patient.

CASE REPORT

The patient, a girl aged 6 years 2 months, was first seen at Birmingham Dental Hospital with a painless swelling of the right maxilla. External examination showed slight asymmetry of the face with reduction of the right ala-nasal fold.

Intra-orally the swelling extended from the midline to the upper right molar area of the alveolar process, being more marked on the buccal than the palatal aspect. This swelling was smooth, and hard except for an area in the centre which was fluctuant.

X-ray examination revealed a large radiolucent area corresponding to the swelling and also showed the presence of unerupted permanent teeth (*Fig.* 1).

The full complement of deciduous teeth was present and it was decided to remove those of the upper right quadrant, to biopsy the lining, and to open the cavity widely.

A diagnosis of dentigerous cyst was made.

Fig. 1.—Radiograph of the radiolucent area, showing involvement of 321|.

Fig. 2.—Radiograph 2 months after operation, showing new bone formation in the cyst cavity and the new position of the permanent teeth involved.

The operation was carried out under general anaesthesia. A flap was reflected on the buccal aspect of the maxilla, exposing the bulging prominence of the cyst. High in the sulcus in the canine region, the mucoperiosteum was attached, through a perforation of the bone, to the cyst lining, from which it was dissected. The deciduous teeth EDCBA| were removed and trimming of the buccal bone carried out. A biopsy was taken of the lining thus exposed. It was possible to see the crowns of the permanent 4321| projecting into the cyst cavity beneath a smooth translucent lining. The cavity was lightly dressed with Whitehead's varnish gauze after suturing the mucoperiosteum back into place. This dressing was removed after 7 days and the cavity was left open.

The patient was seen monthly after the dressing was removed so that eruption of the permanent teeth could be observed.

A Short Communication presented at the meeting held on 9 December, 1963.

Fig. 2 shows a radiograph of the area 2 months after operation. It can be seen that the cyst cavity is becoming obliterated and the teeth involved in the cyst have moved towards the alveolar margin.

One year after operation the upper right central, lateral, and canine were found to have erupted, although out of their normal positions. They were, in fact, markedly displaced, resulting in a diastema of a quarter of an inch between the upper central incisors (*Fig.* 3).

The upper right lateral incisor was found to be positioned palatally in the upper right premolar region (*Fig.* 4).

Orthodontic treatment was indicated to close the median diastema to restore the upper incisors to their correct positions in such a way as to reduce as much as possible the reciprocal movement of any of the anchorage teeth.

Fig. 3.—Models of the erupted teeth.

Fig. 5.—The appliance used to approximate $\underline{1|1}$.

A twin-wire arch was inserted and a coil spring incorporated to approximate the central incisors; molar bands with buccal tubes were cemented on $\underline{6|6}$, and the upper incisors were banded with ripple-lock brackets. The fixed appliance was worn without incident for 6 months, when alinement was complete. *Fig.* 5 shows the appliance used.

The displacement of the upper right lateral incisor was considered to be too severe for correction, and it was therefore extracted.

Vitality tests were carried out after active treatment was completed, and all the teeth responded normally. *Fig.* 6 illustrates the final position of the teeth.

Fig. 4.—Models of the teeth. Note the position of $\underline{2|}$ which has erupted in $\underline{4|}$ region.

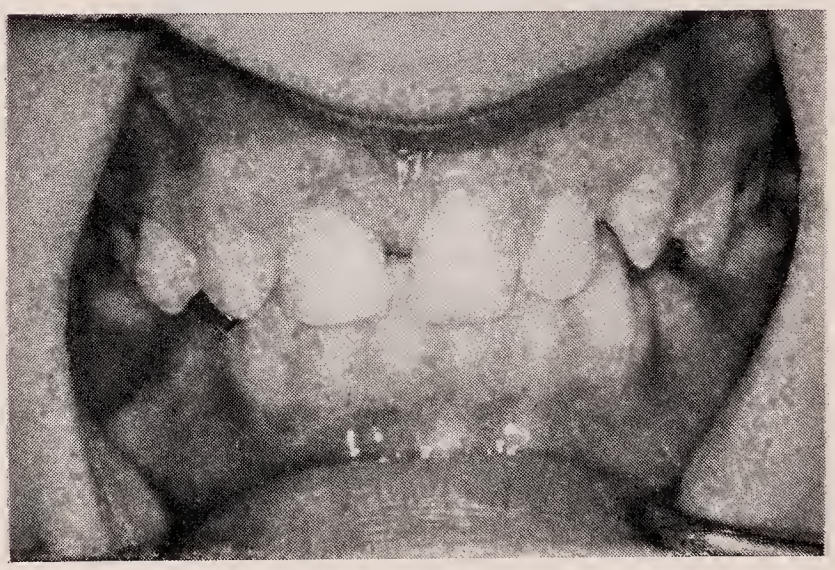

Fig. 6.—Final position of the teeth.

COMMENT

This lesion is interesting because it illustrates the point that even when teeth have been grossly displaced by a dentigerous cyst they are still capable of a reasonable alinement without impairing their vitality. The power of regeneration, which is so good in a child, was

encouraged here by the removal of tension and by the minimum of other surgical interference.

Acknowledgement.—We would like to express our thanks to Mr. A. Byrne of the Photographic Department, Birmingham Dental Hospital, for the photographs.

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DISCUSSION

The President said that throughout all his professional career he had collected cases of transposition of teeth, but he had only six at his command. Here they had a very good case, yet they had mutilated it by taking out the lateral incisor!

These cases of dentigerous cysts were extremely interesting. The case reported here was one that fascinated him more than most. Surely there must be other cases of dentigerous cysts in children where the operation allowed the teeth to erupt and orthodontic treatment was then required; they would all like to hear about such cases.

Mr. K. E. Pringle said he had had a case of a canine just below the floor of the orbit; the tip of the crown faced distally. After the dentigerous cyst had been operated on, the canine had turned round, had found bone to erupt through, and had ended in its proper position just short of full eruption, having travelled a greater distance than its own length. It had not needed orthodontic treatment. He had seen several others of the lower canine that had come up; everyone would have seen such cases.

The President said the strange aspect of this case had been the incisor that had come down so far lateral to its normal position.

Mr. A. J. Walpole Day said he remembered one case some years ago similar to this, involving the lateral incisor on the left side. The surgical procedure had been to remove the lateral and remove the cyst, but the final result had been nothing like so good.

One lesson to be learned from this case was that the minimum surgery done, the maximum chance given to natural processes to heal the cavity, the better would be the result obtained. This was the striking lesson of this case—the amazing powers of recovery of the maxilla.

Professor C. F. Ballard said his own 'vast' experience of this was limited to three cases. He would like to congratulate the orthodontist and the surgeon in this case on their masterly inactivity, which was the right treatment.

He had one suggestion to make from his experience of his three cases: it had always been the lateral that had been displaced. If the surgeon removed the lateral when it was hopelessly out of position there was the chance the buccal segment would move forward and assist in closing the space.

Mr. D. M. Menezes, replying to the discussion, said he would agree with Mr. Pringle's suggestion that no orthodontic treatment be carried out, but in this particular case the purpose of treatment had been to close the diastema and aline the teeth.

In reply to Professor Ballard, Mr. Menezes said he had seriously considered removing the lateral incisor earlier, but, as would have been noticed from the slide, he had left it as long as possible, because he had not been sure what the condition of the remaining unerupted teeth would be: he had eventually removed the lateral incisor because the space had been closed from behind.

A CEPHALOMETRIC APPRAISAL OF THE DEVELOPMENT OF MALOCCLUSION

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INTRODUCTION

GREAT progress has been made in recent years in isolating some of the factors involved in the aetiology of malocclusion. Nevertheless, there exists an absence of clarity as to how these factors interact in specific instances. On these occasions explanations do not possess the simplicity normally associated with scientific solution.

This may be the result of missing factors, or inaccuracies in current theory. Some observations which have contributed to present-day aetiological concept have been based largely on clinical observation and recollection, which are inevitably fraught with the tendency to see what one believes, and, in the case of the growing facial complex, with the hazard of optical illusion. Again, surveys aimed at obtaining specific evidence by measurement have often been carried out on subjects aged 10, 12, or 14 years of age. Since these are the ages related to orthodontic treatment, a sample can easily be found of a size to satisfy the statistician. It would, however, be pointless to satisfy statistical requirement with material unrelated to the subject of investigation.

It was thought that events around the time of birth would have the greatest significance, and that conditions existing at that time might have less direct correlation with those pertaining later than is popularly believed.

This work aims to test current concept on aetiology against the evidence of a thorough analysis of a random sample of malocclusions. In order to do this, it was necessary to divorce the mind from preconceived notions and to follow up only such clues as were indicated by the analysis.

Table I.—DETAILS OF THE SAMPLES USED IN THE INVESTIGATION

Total Number of Individuals 36. (Male, 14; Female, 22)

Incisor Relationship		*Average Age Span*	*Individual Maximum and Minimum Age*
Angle's Class I	11	5 yr. 1 mth. to 11 yr. 8 mth.	3 yr. 10 mth. 16 yr. 4 mth.
Angle's Class II, div. 1	15	3 yr. 10 mth. to 9 yr. 9 mth.	2 yr. 4 mth. 11 yr. 9 mth.
Angle's Class II, div. 2	5	3 yr. 8 mth. to 10 yr. 6 mth.	2 yr. 8 mth. 14 yr. 1 mth.
Angle's Class III	5	5 yr. 7 mth. to 11 yr. 1 mth.	5 yr. 1 mth. 13 yr. 3 mth.

Dental Base Relationship		*Incisor Apical Relationship*	
Skeletal I	12	Class I	7
Skeletal II	14	Class II	19
Skeletal III	10	Class III	10

Average number of radiographs per head = 6 (3 before and 3 after upper central eruption)

Under 3 yr. at first radiograph	6	Brothers	2 pair
,, 4 yr. ,, ,, ,,	12	Sisters	1 pair
,, 5 yr. ,, ,, ,,	24	Identical twins	1 pair
Serial plaster models available for 30 cases		Tongue behaviour atypical 5 cases	

No orthodontic treatment, by appliance or extraction, instituted for any individual during period surveyed

The sample itself would have to be of a type that allowed study of the process of facial development and tooth eruption over a period from as near the date of birth to as long after that event as possible.

The Sample.—It was therefore necessary to obtain records of developing occlusions starting from the earliest possible age and proceeding to as late an age as could be found. Although models and clinical notes taken at strategic

Presented at the meeting held on 9 December, 1963.

intervals would be helpful, the most important records to assist a study of this period would be lateral radiographs.

Patients who have been serially radiographed from a really early age, well before upper incisor eruption to well past the full eruption of these teeth, are rare. Because of this, and the fact that the first stage of investigation was to be into the eruptive behaviour of the central incisors, the sample was limited. It would take a minimum of six years to add to the number by instituting serial radiographic study of additional patients.

Thirty-six patients had, however, been so surveyed in the past, for various reasons, and it was decided that a thorough analysis of these could be as valuable as a superficial analysis of a greater number. Details of the sample are shown in *Table I*.

The sample is a cross-section of the world of malocclusion and cannot be regarded, therefore, as representative of the population. It does not, in fact, represent, proportionately, malocclusion as it manifests itself for treatment. Great care must be taken over the use of averages in a sample, such as this, containing an almost even representation of skeletal abnormality. The variables involved would be not only opposite, which is to be expected, but also equal, and therefore if averages were taken, the resultant figures would tend towards those associated with the normal.

PART I: INVESTIGATION INTO THE ERUPTIVE BEHAVIOUR OF THE CENTRAL INCISORS

The object of the first experiment was to discover the variations in the behaviour of teeth before and after eruption, and to attempt to trace the cause of such behaviour.

SYSTEM OF MEASUREMENT

SN, maxillary, and mandibular planes were used against which to measure the central incisor angulation at each stage of the development for each patient (*Fig.* 1). Upper and lower central incisor angulations were measured against all three planes, as a check on accuracy, together with the inter-incisal angle. In addition, the angles SN to incisal tip of the centrals was used (SNI), supported by perpendiculars drawn from both incisal tips and apices to SN. These latter measurements were taken in order to detect the relative movement of incisal tip and apex and so help establish where changes of angulation to the horizontal took place.

The problem of obtaining accuracy of long axis measurements for the partially calcified tooth was overcome by the making of a template from the outline of the whole tooth, derived from the clearest of the later radiographs for each case. This was used by superimposition on the crown of the developing tooth and the whole outline traced, including the hypothetical root. The points representing incisal tip and apex were marked on the template so that consistency in this matter was supplied to each measurement. Failure to have done this would have promoted a potential 3–5° error from tracing to tracing.

Before tracing, the radiographs for each patient were placed in random order. Measurements for each tracing were taken, and later tabulated in chronological order. Once assembled in order each set of readings acted as confirmation, or otherwise, of those which preceded or succeeded it. The deliberate 'shuffling' of the films before tracing was aimed at minimizing the risk of following preconceived notions.

Tables for each patient were thus compiled, and from these tables were extracted the readings at three important stages of development for each individual.

1. The earliest record, giving the developmental position and angle of the central incisors (or as near to it as was possible, bearing in mind that the youngest patient was 2 years 4 months and the oldest 7 years when first X-rayed).

2. The angle and position at the point of eruption of the upper central incisor.

3. The final angle as recorded from the last radiograph to be taken for each individual.

These three readings were set down for each patient in a further table, analysis of which would give a general picture of incisor eruptive behaviour. The findings of this general analysis were then compared with any exceptions which existed in the individual tables. Here, as elsewhere, any hypothesis formed would have

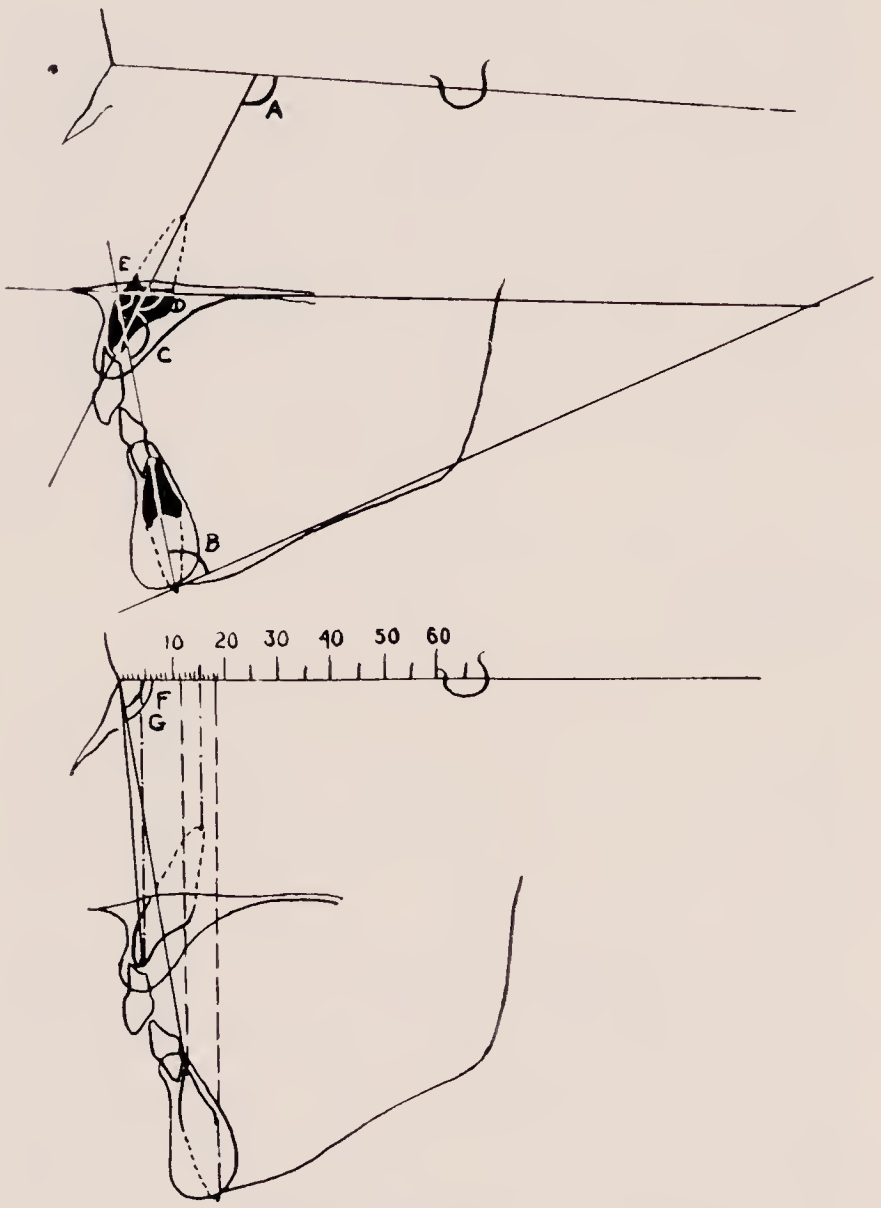


Fig. 1.—Illustrating measurements used in assessing incisor eruption. The angles A to E represent the angle of the long axis of upper incisor to maxillary and SN plane, of lower incisor to maxillary and mandibular planes, and inter-incisal angle. The angles F and G are those between SN plane and a line from N to upper and lower incisal edges. Linear distances measured along NS of vertical projections from incisal edges and apices of upper and lower central incisors.

to be in keeping with both the rule and the exception. The whole process of measurement was later repeated to assess degree of accuracy.

PRE-ERUPTIVE BEHAVIOUR OF CENTRAL INCISORS

As can be seen from *Tables II and III*, the pre-eruptive behaviour does not conform to a universal pattern. Some central incisors uprighted, some remained at a constant angle, others became more proclined.

Since the majority showed a tendency to upright, this was taken to be the usual behaviour. It was noted that this uprighting took place most rapidly when the incisal tip of the central incisor reached the buccal wall of the alveolar process.

It would, perhaps, make for understanding if, at this point, the typical pre-eruptive behaviour of the upper incisors was described together with the rationale for that behaviour, as finally deduced. Exceptions can then be mentioned to show how these reinforce the conclusions.

Fig. 2 shows the eruption of an upper central incisor in three stages. Stage 1 shows the central crown supported on its distal aspect by the overlap of the mesial of the developing lateral. The lateral incisor itself is supported by the palatal wall. As these teeth erupt, the slope of the palatal wall guides central and lateral towards the buccal. At the same time the teeth approach the narrower occlusal aspect of the alveolar process. Stage 2 shows the labial surface of the central incisor close to the buccal wall. It is at this point that the central incisor uprights most rapidly, the fulcrum being supplied at a variable point of contact on the mesial of the lateral. The incisal tip of the central rarely drops back in relation to nasion, the uprighting being achieved by the forward movement of the open apex in a ratio of 2 : 1 or 3 : 1 with the incisal tip. Since the root is hypothetical, this indicates a pivotal point within the crown. The movement of teeth within the bone assists further eruption, but in certain cases there may be a lack of space which delays the eruptive process. In these cases alveolar enlargement shown in Stage 3 occurs slowly. The cross-sectional enlargement is necessary to continuation. Both palatal and buccal walls can be affected. Although the cross-sectional conformity of the alveolar process may alter, the position of the alveolar crest relative to nasion remains unaltered during the occurrence.

These were the typical stages, and the conclusion was that teeth take the line of least resistance during eruption. The exceptions to be mentioned later were mainly responsible for this conclusion.

The three elements in offering resistance, in reverse order of importance, are: (1) Deciduous predecessors; (2) Neighbouring developing permanent teeth; (3) Alveolar walls.

of an apparent inclined plane by uneven root resorption did not seem to alter the course of tooth eruption within the bone. Deflexion of a permanent tooth to a warrantable degree is

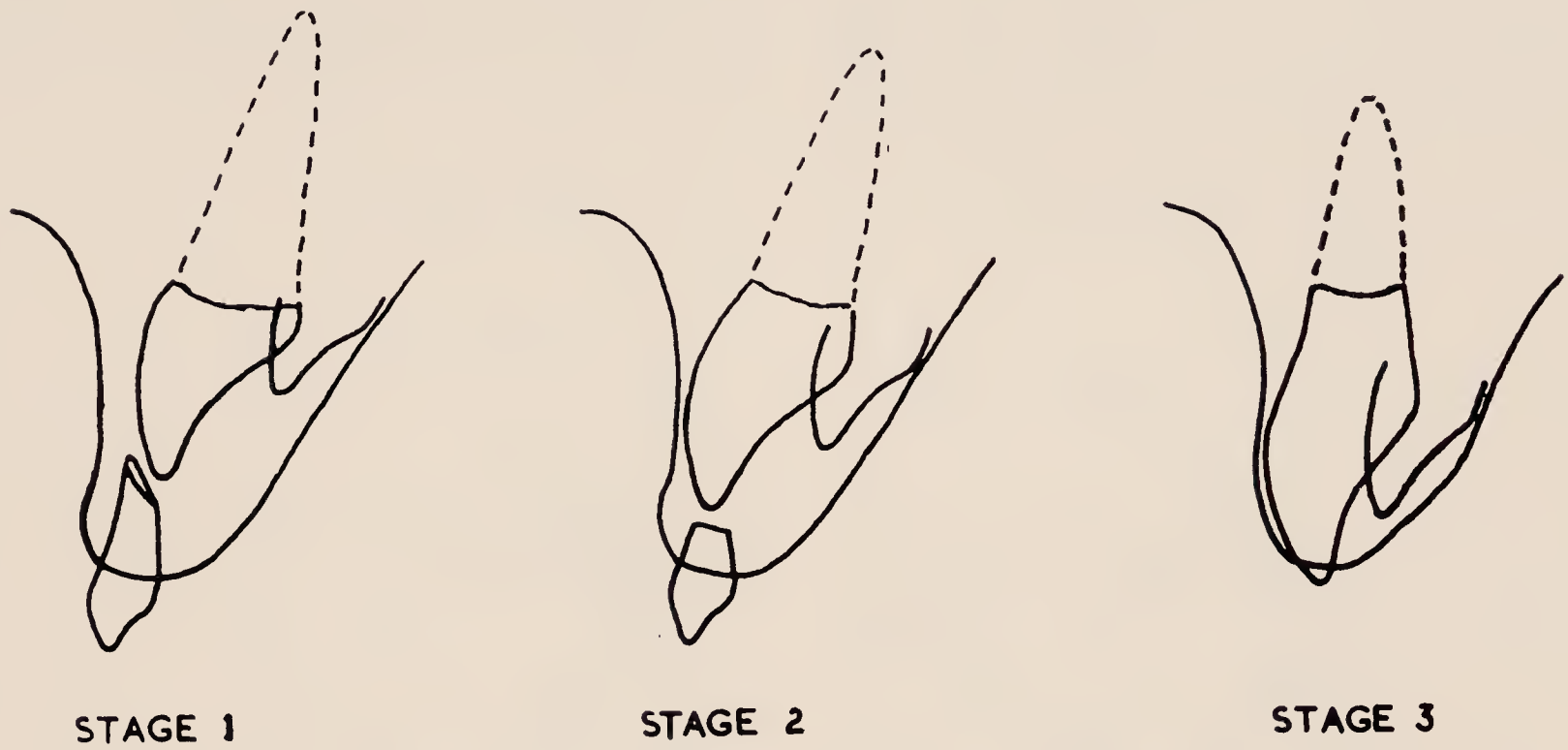


Fig. 2.—Diagram illustrating three successive stages in the eruption of an upper central incisor.

Table II.—Summary of the Behaviour of Individual Incisors before Eruption

	Angle Increased (proclined)	Angle Decreased (Uprighted)	Bodily Forward Movement	No Change	Not Measurable
Upper: (Long axis to SN plane)	5	18	4	1	8
Lower: (Long axis to mandibular plane)	3	15	4	3	11
	8	33	8	4	19

Table III.—Details of the Pre-eruptive Behaviour of the Central Incisors

	Maximum Degrees Change of Long Axis		Maximum Change SNI Angle		Average for Sample	
	+	−	+	−	Long Axis	SNI Angle
Upper	12°	13°	7°	2°	−2·5°	+1·9°
Lower	11°	17°	4°	2°	−1·7°	+1·0°

1. Deciduous Teeth.—Uneven resorption of the root of a deciduous tooth does not alter the behaviour of the successor so long as the latter is in close communication with its developing neighbours. Even where the successor was unsupported by neighbouring teeth, as was so in some of the patients surveyed, the formation more likely to occur when a fragment of deciduous tooth is retained after the eruption of its permanent replacement. The fragment, retained by fibrous tissue, is then acting as a foreign body.

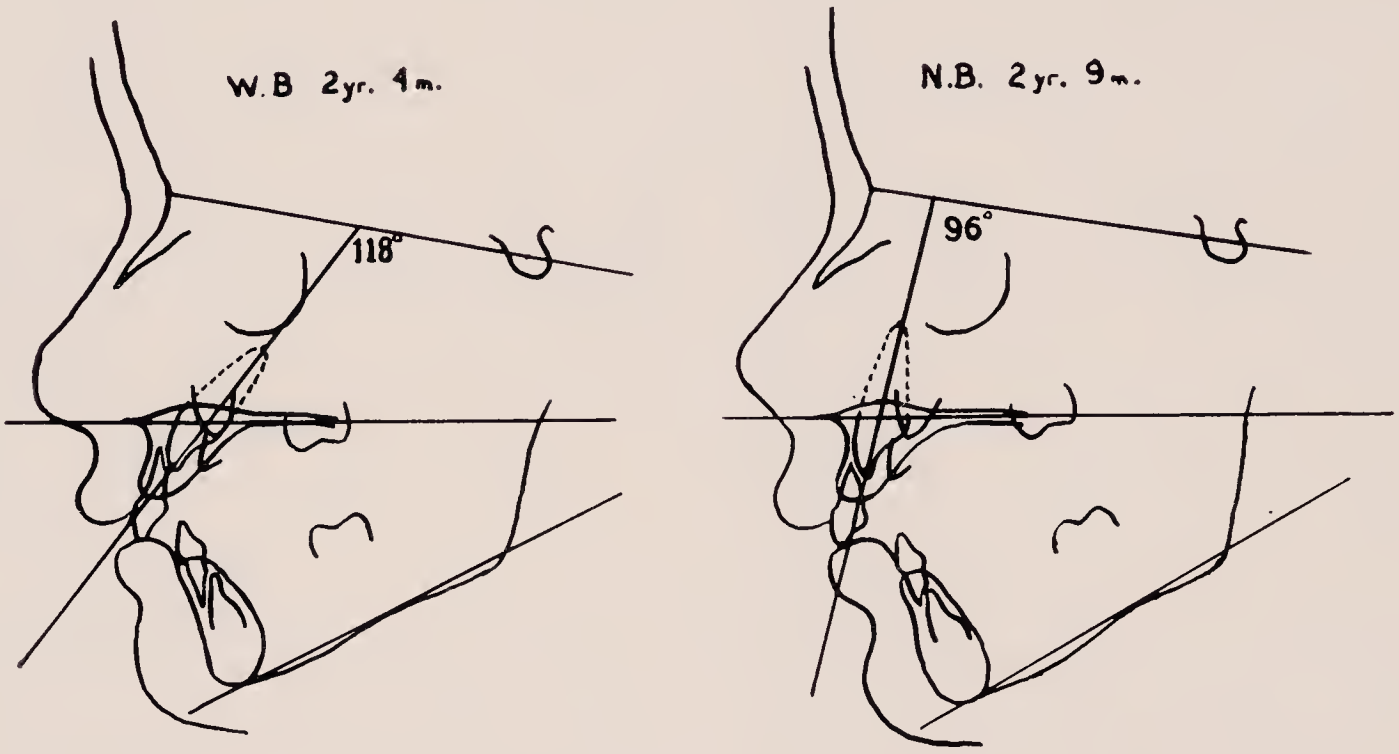
2. Permanent Teeth.—Unlike the deciduous teeth, the permanent teeth, forming in close

association within their bony environment, are unlikely to resorb, and, if they obstruct one another, the situation can be most readily eased by moving out of one another's way. The nature and degree of these movements will be determined by the conformity and cubic capacity of the alveolar process, in association with the relative developmental positions of the incisors and canines. Exceptionally wide arches, small teeth, small laterals alone, or a high palatal position of the canines, can mean the early breakout of the lateral incisors from their developmental position in support of the distal aspects of the centrals. In cases where the buccal alveolar wall is upright, the laterals will describe their full forward arc at the incisal tips, guided by the palatal wall, before contacting the buccal wall, whilst the centrals, bereft of support, continue to upright, thereby producing a Class II, division 2 type of incisor formation. This can occur in conjunction with any of the three skeletal forms.

By contrast, the narrow arch, with the canines developing more to the buccal and lower, can prevent the laterals from achieving their position in the arch, even after eruption. They remain palatally behind the centrals.

The relationship of the teeth of the labial segment within bone, in association with space available, will in such ways influence the ultimate occlusal conformation on full eruption.

3. The Alveolar Process.—It has been shown that when an erupting tooth is confronted by the alveolar wall it will be deflected, and that this is of importance in determining the position at eruption. The alveolar crest position, relative to nasion and the cross-sectional shape, normally remains unaltered during the eruptive process. Nevertheless, it has been mentioned that if the capacity of the alveolus is inadequate at any point to allow further eruption, delay occurs whilst buccal and/or palatal enlargement takes place. Anteroposterior increase was found to occur in 10 cases up to a maximum total of 4 mm. The process is slow, and either limited by environmental factors, or self-limiting from within. If the maximum enlargement is still insufficient, the central incisor may erupt, at least through bone, on the buccal surface. The resistance of the outer alveolar plate was further indicated by 3 cases which showed early rotation of one or more of the central incisors. On their approach to the buccal wall, the usual uprighting was



	W.B. TO SN PLANE	W.B. TO MAXILLARY PLANE	N.B. TO SN PLANE	N.B. TO MAXILLARY PLANE
ALVEOLAR SLOPE	108°	122°	107°	115°
UPPER CENTRAL INCISOR AT ERUPTION	105°	119°	104°	112°
FULLY ERUPTED	113°	126°	112°	120°

SN–ALVEOLAR CREST ANGLE CHANGED 2° IN W. B., and 1° IN N. B. OVER 8–YEAR PERIOD

Fig. 3.—Diagram to illustrate the contrasting behaviour of upper central incisor during eruption in two sisters. Although differing in position in infancy, the figures given show their similarity after eruption.

accompanied by the correction of the rotations. Another anomaly was a case of absent upper lateral incisors. The centrals, bereft of their usual support, descended towards the palatal wall and attained their eruptive position through guidance of the cingulum against that wall, instead of incisal tip against the buccal.

An illustration of the typical and atypical behaviour of the upper central incisor within bone is shown by two sisters in the group analysed (*Fig.* 3). These exhibited Class II, division 1 malocclusions, and possessed similar skeletal and alveolar patterns. Their cases also illustrate that although, on average, the original developmental angle of the central incisors is related to the alveolar slope (i.e., the more vertical the alveolar process the more vertical the incisal developmental angle) there is no strict correlation. Individual cases, such as these, show sufficient variation to indicate that tooth and alveolar angulation are but loosely associated.

The alveolar long-axis angle in the two sisters was 107° and 108° to SN. The developmental angle of the central incisors of one was 96°, of the other 118° to SN (107° and 133° to maxillary plane). The centrals of the first proclined within bone whilst the second retroclined to erupt at similar angles of 104° and 105° to SN respectively. The first pivoted with more forward movement at the open apex than at the incisal tip, the second with more forward movement at the tip than the apex.

This example serves also as a reminder that it has been shown that not all central incisors upright during eruption. Considerable individual variation was shown. In the upper arch maximum uprighting was 13°, maximum change by proclination 12°. In the lower arch maximum uprighting was 17°, maximum proclination 11° (*Table III*).

It was found that those upper incisors which proclined had a low developmental angle to SN (lower incisors to mandibular plane). None, however, achieved their new proclined position by forward movement at the incisal tip alone. Part, or sometimes the whole, of the effect was brought about by lingual or palatal movement at the open apex.

Where no change in angulation occurred, the slope of the teeth and the slope of the alveolus were similar. Only 4 of the 12 cases which showed no change in angle, however, did so by direct eruption; the remainder showed a bodily forward movement within bone.

It was found that, on average, the behaviour before eruption of the incisor teeth did not show significant differences from one classification of malocclusion to another, nor was the process different in the lower arch as against that described for the upper.

The incisor teeth before eruption therefore respond to their environment. The combination of their own bulk, dental base dimension, alveolar slope, and conformity in cross-section, will determine tooth position and relationship on eruption. It can be inferred that the teeth of the cheek region would respond similarly to the guidance of the alveolar process. This guidance, in respect of the upper incisors, was at times so faithful that the teeth followed depressions and eversions of the buccal wall on their pilgrimage to the surface.

The next stage of investigation should therefore be to determine, and if possible substantiate, the reasons for which alveolar slopes and cross-sectional shapes come about.

There are those who believe that the solution to this riddle lies with genetic determination, and those who aver that much is due to the interplay of muscular forces.

That the teeth themselves may come under muscular influence on eruption is strongly suggested by their behaviour immediately upon eruption. The figures which follow show that the dominant pre-eruptive behaviour of uprighting is suddenly and immediately changed on eruption to the opposite one of proclination. The typical manner in which the teeth move, during this act, is identical with that displayed in response to pressure stimulus from an appliance (i.e., tilting about the apical third).

POST-ERUPTIVE BEHAVIOUR OF THE CENTRAL INCISORS

At this stage, enough of the post-eruptive incisor behaviour will be mentioned to indicate

the possible presence and influence of environmental forces. The remainder will be disclosed later in support of other contentions. The system of measurement used was the same as for the pre-eruptive behaviour. *Tables IV and V* show the dominant tendency for proclination, which is the reverse of the pre-eruptive procedure. The proclinations came about by a forward tilting, the incisal tip moving labially accompanied by variable, but usually smaller, amounts of lingual or palatal apical movement. In 4 cases of proclination, however, this apical movement accounted for the whole of the change in angulation.

The three instances where no change in the long axis was shown nevertheless exhibited a bodily forward movement of 2–3 mm. in a 5-year period. This was in some degree related to general growth.

These findings tend to show the presence of active forces around the erupting tooth and to support the belief that, on eruption, teeth settle into positions of equilibrium amongst themselves, and within their soft-tissue environment.

Table IV.—Summary of the Behaviour of Individual Incisors after Their Eruption

	Angle Increased (Proclined)	Angle Decreased (Uprighted)	Bodily Forward Movement	No Change	Not Measurable
Upper (Long axis to SN plane)	19	10	3	0	4
Lower: (Long axis to mandibular plane)	31	1	0	0	4
	50	11	3	0	8

Table V.—Details of the Post-eruptive Behaviour of the Central Incisors

	Maximum Change in Degrees of Long Axis		Maximum Change SNI Angle		Average for Sample	
	+	−	+	−	Long Axis	SNI Angle
Upper	11°	24°	9°	2°	+1·5°	+3·6°
Lower	28°	2°	9°	2°	+11·8°	+4·5°

The decreases in angulation of the incisors, on the other hand, were all brought about by the buccal movement of the apex and not by palatal or lingual movement of the crown. These decreases involving buccal apical movement were liable to continue insidiously for periods long after full eruption. One such case showed that this process was still continuing seven years after eruption.

In contrast, the increases in angulation, or proclinations, took place rapidly and usually ceased, or became imperceptible, after varying periods of up to eighteen months from the date of eruption.

Bearing in mind the apparent influence of the alveolar pattern on the pre-eruptive process, it would not seem illogical that at least the occlusal aspects of the alveoli should also be influenced by the same muscular environment. This would represent an ideal mechanism to ensure that the teeth were guided to near their correct position of balance.

It was decided, however, that before proceeding to attempt to demonstrate soft-tissue influence, the skeletal patterns of each individual should be subjected to further examination.

A subsidiary object, at this stage, was to detect any feature or features, readily recognizable clinically, that might be related to any particular alveolar pattern.

PART II: THE ALVEOLAR PROCESS. INVESTIGATION INTO THE CAUSATION OF CROSS-SECTIONAL SHAPE AND LONG AXIS ANGULATION

GENERAL SKELETAL ANALYSIS

Each of the serial radiographs for each individual was further examined in the hope of establishing some link between skeletal and alveolar patterns. Linear measurements were added to those angular ones already noted during the investigation on incisor eruption. Some further angular measurements werc also taken at this stage, as shown in *Fig.* 4. All measurements were tabulated.

It was found that, as far as angular measurements were concerned, no direct correlation existed between these and any particular alveolar form. As soon as the skeletal angular measurements of as few as half a dozen patients, selected either at random or because of a similarity in alveolar form, were made into averages, it was seen how individual variation was thereby expunged and the resultant figures were those which could well be associated with the normal skeleton.

It was possible to demonstrate the lack of direct relationship between alveolar and angular skeletal form in another way. Three patients possessed skeletal patterns, the main angular measurements of which were within a degree the same vertically and horizontally, yet the alveolar conformities of each could hardly have been more different.

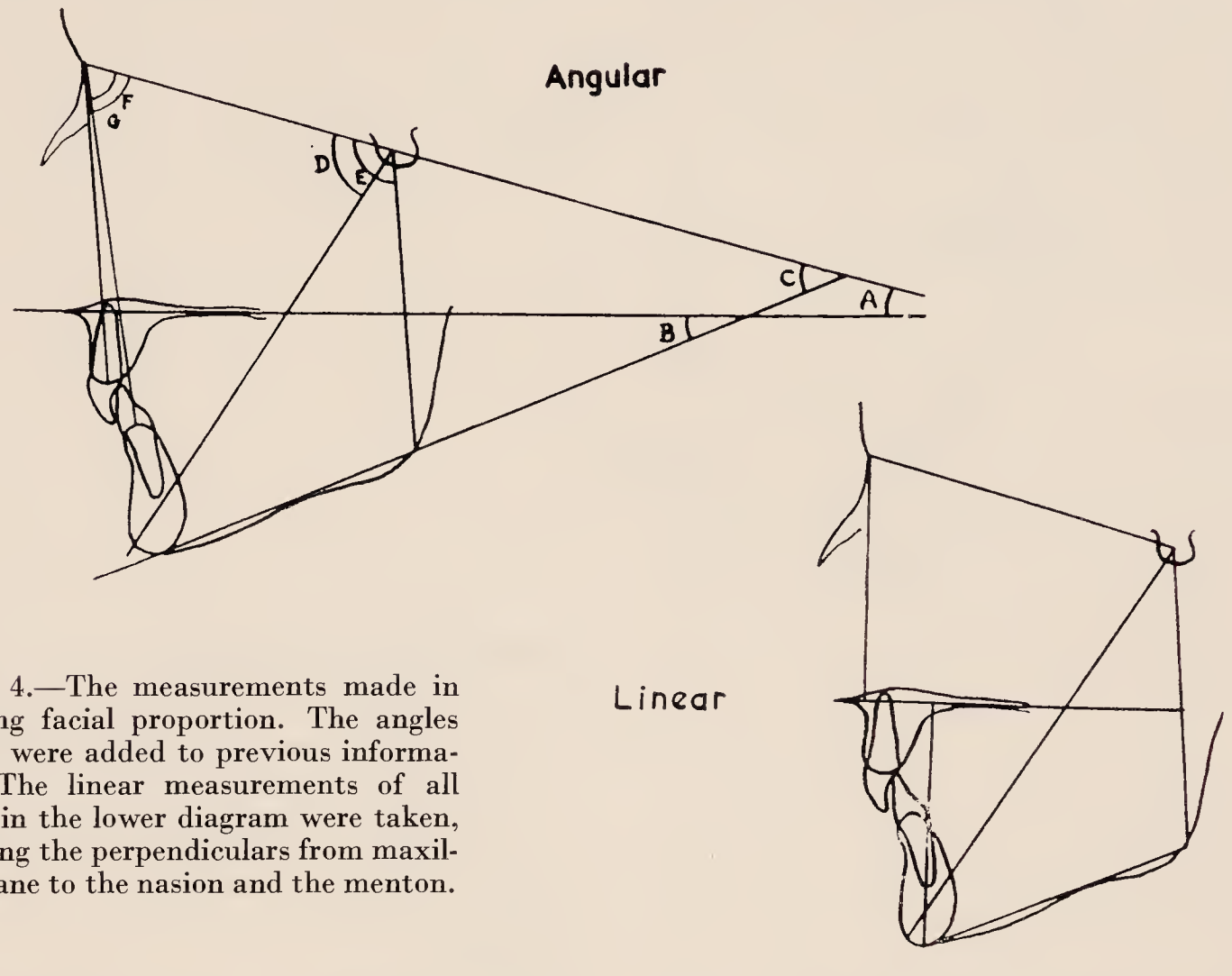


Fig. 4.—The measurements made in assessing facial proportion. The angles A to G were added to previous information. The linear measurements of all planes in the lower diagram were taken, including the perpendiculars from maxillary plane to the nasion and the menton.

The tendency for skeletal variations to cancel out on average was to be made great use of later in the investigation.

At this point pursuit of links between skeletal and alveolar patterns was interrupted by the emergence of an apparently significant correlation.

The angle SN plane to alveolar crest (upper) drew attention to itself by subtending 79° precisely at nasion, in one-third of the patients, regardless of all variation elsewhere. To obtain an exact figure repeatedly was indeed a rarity. In those cases where the exact angle was not obtained, variation either side was small. It was also noted that this angle changed little, if any, during the course of an individual's development. Such a situation was clearly deserving of additional scrutiny.

SYSTEM OF ALVEOLAR MEASUREMENT
(*Fig.* 5)

In addition to the angle subtended by the upper and lower alveolar crest to SN plane at the nasion (points 1 and 2), the angles to the same plane subtended by the estimated points of alveolar origin (3 and 4), the inner and outermost points of the anterior cross-section of the symphysis of the mandible (5 and 7), and the lowest point of the inferior border of the symphysis (6) were measured.

The long axis angulation of the anterior cross-sections of the upper and lower alveolar processes was estimated by dividing each horizontally into three sections and connecting the alveolar crest and the centre points of the horizontals by a straight line. The slope of the processes could then be measured against the SN plane, maxillary plane, or mandibular plane. Additionally, the interalveolar angle was measured.

Linear measurements were also taken. The height, at each stage of development, of the upper alveolar process was taken from the alveolar crest to the maxillary plane by dropping a perpendicular from the maxillary plane to the crest. This measurement for the lower alveolus included the whole depth of the

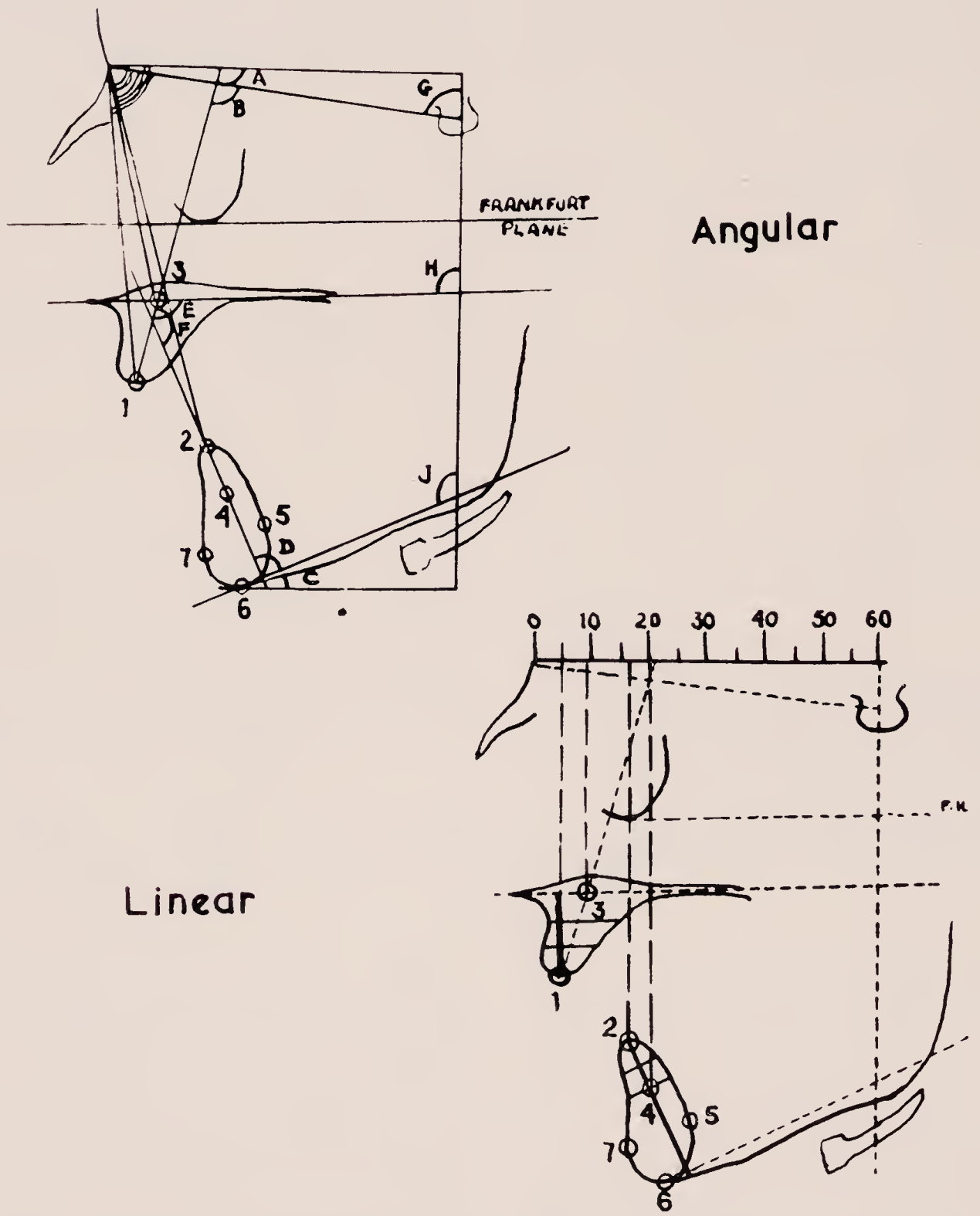


Fig. 5.—Measurements used in assessing alveolar form and position. Linear measurements of alveolus made perpendicular and parallel to maxillary and mandibular planes. Anteroposterior position of crest and base of alveolus measured from N as a projection on the horizontal plane.

mandible; the distance taken was the perpendicular line from the lower alveolar crest to the mandibular plane.

The widths of the processes across the horizontals, already mentioned, were added to the information.

As before, the angles and linear dimensions for the earliest record, at the time of upper central incisor eruption, and at the time of the last radiograph for each individual were extracted from the individual tables and separately tabulated. The interim radiographic tracings acted as a check on the accuracy of those at these particularly salient times.

Up to this point conventional planes had been selected against which to assess angles. All angles, equally conventionally, have two sides and the alterations in the position of either side, or both, will alter the angle.

For example, the angle SN to upper alveolar crest could alter either by variation of the SN plane, or the nasion to alveolar crest line, or both. The same applies to other angles.

It was necessary to establish the true position of the alveolar processes and their angulation, so that each case was comparable with others. In order to do this, measurements would have to be taken against a plane, or planes which had a minimum variation between themselves, and from individual to individual.

The SN–maxillary, SN–mandibular, and maxillary–mandibular plane angles may be reasonably constant throughout growth within an individual, but from person to person they show considerable variation. The variation is shown by this sample:—

SN–maxillary plane: betwcen 1° and 15°=14°

SN–mandibular plane: between 27° and 44°=17°

Maxillary–mandibular plane: between 19° and 38°=19°

The superimposition of radiographic tracings of different individuals showed very clearly how these variations would operate in the comparison of different individuals. Variation of angulation of these planes would be superimposed on the variations shown by the alveolar processes, and the outcome would be highly misleading.

Compensatory arithmetic, such as that often used to assess lower incisor angulation against the variability of the mandibular plane, was considered as a means to eliminate the influence of maxillary, as well as mandibular-plane, variation in this issue. Variation of the SN plane, however, would still remain a mystery.

The angle SN to upper alveolar crest was of the utmost interest at this stage, and therefore SN plane variation was of similar importance. Further, one had to bear in mind that the position, angulation, and shape of the alveolar processes, together with any progressive changes that might be found to take place, might be attributable to muscular activity of tongue or lips.

The required ideal plane would seem to be one related to the patient's postural vertical, and as consistent as possible from individual to individual. Against any such line, individual variation of SN and the other horizontal planes could be assessed. A vertical plane would also have the advantage of being at right angles to the anteroposterior activities of tongue and lip.

No such plane existed: the Frankfurt plane, however, did. Since this plane was on average clinically related to the horizontal, with the patient's head erect, it followed that a line at right angles would be near to the patient's postural vertical.

Accordingly, in each case a line was drawn perpendicular to the Frankfurt plane and projected upwards through sella and downwards in the opposite direction where it normally passed through the posterior aspect of the dorsum of the tongue and the hyoid bone (*Fig.* 5).

The difficulty, and resultant inaccuracy, in determining the anatomical points to establish the Frankfurt plane, encountered in tracing single radiographs, was offset by the fact that some six or more were available for each patient. This helped to reduce the average tracing error to 0·7°, with an individual maximum at 2·5°.

Once the vertical plane had been established, the picturc was completed by adding planes parallel with the Frankfurt from thc nasion to

the vertical and from the lowest point of the mandible to the vertical.

The angulations of the long axes of the alveolar processes were measured against these horizontals.

Perpendiculars were also dropped from the nasion horizontal to the points of interest (*Fig.* 5). The distances of these perpendiculars behind, or in front of, the nasion acted as a check on position and positional changes of the alveolar points, thereby substantiating the results obtained by angular analysis.

Establishment of these points, for each individual, made possible comparative analyses between any one point and any of the remainder.

ANALYSIS OF ALVEOLAR MEASUREMENTS

It was found that the average angle made by SN plane to the vertical was 82°, with an individual variation of ±4°.

It would be wrong to assume that this variation was due entirely to the changeability of SN, since there is no guarantee that the Frankfurt plane could not itself be responsible or contribute. What is established is that there exists a constancy between these two planes almost twice as great as that between any other two planes mentioned previously.

The assessment of the true alveolar angulations could therefore be expected to be reliable if made via direct measurement against the horizontal. In case there should be any significant difference shown, a separate table was prepared for angles against SN.

The angle between the long axis of the upper alveolus and the SN plane, the angle B (*Fig.* 5), showed a variation between 85° and 73° at the nasion for the individuals (mean 79°). This indicates a 12° difference—the anteroposterior equivalent at the crest of approximately 13 mm. in a face of average dimensions. This distance was confirmed by the angular measurements against the horizontal instead of SN, and by the linear 'per perpendicular' assessment. Nevertheless, approximately 80 per cent (possibly as high as 86 per cent) of the individual crests fell within a 5-mm. bracket anteroposteriorly. It is interesting to note that of the 26 Class I and Class II, division 1 occlusions involved in the sample only 2 of the Class II, division 1 failed to have the upper alveolar crest within the narrow confines of ±2·5 mm. either side of mean. These two cases were, however, well on the plus side and join the other non-conformists of Class II, division 2 and Class III which escaped on the minus side.

The high degree of consistency in the position of the upper alveolar crest, however, was excelled by that of the estimated position of the upper alveolar base. This point was taken as being established by the intersection of the maxillary plane and the long axis of the alveolus. The mode of assessment of the latter has already been described.

The variation anteroposteriorly, evaluated as for the upper alveolar base, was approximately 9 mm., 90 per cent of cases falling within a 5-mm. bracket.

The same systems of measurement were applied to the mandibular arch. As is to be expected, far less consistency was found.

The lower alveolar base, the crest, the innermost border, and the lowest part of the symphysis all showed a similar anteroposterior scatter of some 20 mm. Nevertheless, in each instance between 65 and 70 per cent were within the 5-mm. bracket.

The lower alveolar base was deemed to be a point on the long axis measurement of the lower alveolus opposite the B point. This method of assessing the lower alveolar base together with that described for the upper, when used for determining skeletal pattern, was found less misleading than points taken on the changeable peripheries of the structures such as the A and B points. This was particularly so of the estimation of dental base relationships for Class II, division 2 incisor relationships.

In order to clarify the foregoing description of the relative variabilities of the alveolar reference points a chart was prepared (*Fig.* 6). The position of the alveolar crests, bases, and the lowest point of the symphysis of the mandible were separately plotted on a diagram of a facial skeleton, the outline and anatomical points of which were established from averages of distances and angles taken

from the full sample at the time of central incisor eruption. Angles at the nasion, and perpendicular linear measurements below and behind that point, were used to establish the

Table VI.—Showing the Angles made by the Long Axes of the Anterior Alveolar Processes to the Horizontal. The Figures at the Bottom of the Columns are Averages

Skeletal I (12 Cases)		Skeletal II (14 Cases)		Skeletal III (10 Cases)	
Upper	Lower	Upper	Lower	Upper	Lower
102°	113°	109°	103°	111°	112°
112°	125°	101°	117°	112°	117°
108°	118°	103°	121°	106°	112°
120°	114°	115°	114°	109°	123°
113°	100°	108°	119°	108°	112°
107°	124°	107°	116°	107°	118°
108°	101°	108°	115°	100°	121°
103°	112°	111°	110°	105°	114°
100°	112°	106°	114°	111°	107°
113°	117°	112°	123°	97°	112°
102°	120°	107°	111°		
105°	115°	93°	110°		
		96°	120°		
		105°	112°		
107·7°	114·0°	105·8°	114·6°	106·6°	114·8°
Total 221·7°		Total 220·4°		Total 222·8°	

plots. Dotted circles have been drawn to encompass the points plotted, and it is possible to see the degree of variation in the vertical, as well as the horizontal, dimension. The small continuous line circles have a 5-mm. diameter. It is important to realize that the figures result from superimposition on the nasion only.

It can be seen from the diagram and deseription that the upper alveolar crest positions show a wider anteroposterior scatter than the points representing the base. The lower alveolar crest scatter, anteroposteriorly, is the same as that for the variability of the base. This does not mean that the upper alveolar process alone shows variation in crest to base and that the lower alveolar process crest-to-base relationship for each individual is always the same.

The crest-to-base relationship in the upper showed a difference, as measured between

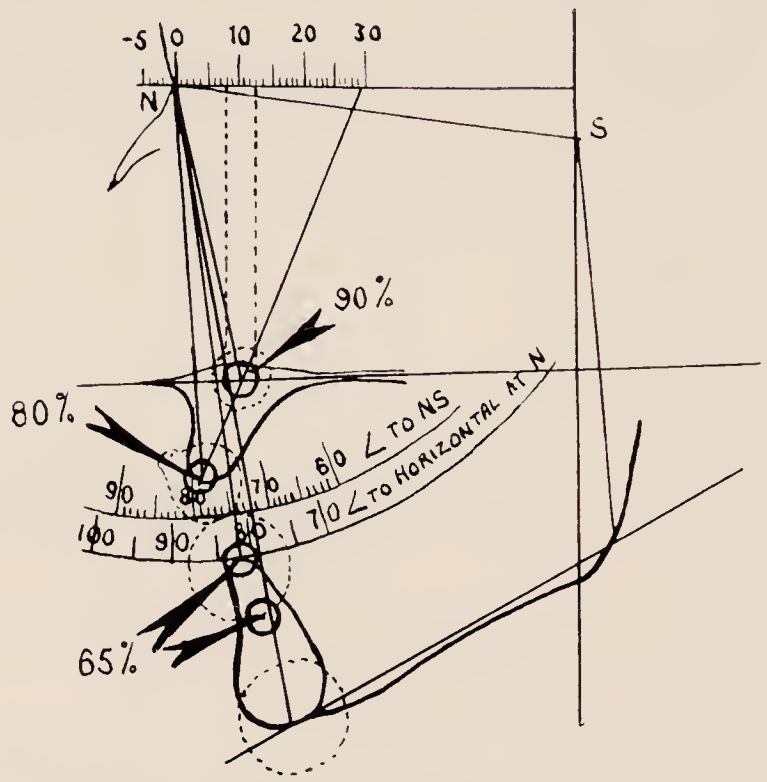


Fig. 6.—Showing the variation in position of the crest and base of alveoli in the sample, at the time of upper incisor eruption. The small circles of 5-mm. diameter; the large dotted circles enclose all plots of a given point.

Table VII.—Average Figures for Upper and Lower Alveolar Proclination, grouped according to Angle's Classification

Class 1		Class II, Div. 1		Class II, Div. 2		Class III	
Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
106·4°	117·5°	109·9°	112·8°	100·0°	113·0°	104·0°	114·4°

perpendiculars, of a maximum of 11 mm. and minimum of 2 mm. (= 9 mm.). The lower showed a maximum difference of 8 mm. and a minimum of 3 mm. (= 5 mm.). The upper, therefore, which is the larger structure, shows a tendency overall to vary more than the lower, in base-to-crest relationship.

This variation can be demonstrated in another way, namely, by the alveolar long-axis angles to the horizontal. *Table VI* shows these figures. The sample has been divided into three groups, representing dental base relationship based on the anteroposterior, 'per perpendicular', distance between upper and

lower estimated alveolar base positions. The normal dental base relationship distance assessed thus was found to be approximately 4–6 mm. Those with greater difference than 6 mm. were graded as Class II, those with less than 4 mm. Class III. In *Table VII* the same factors are classified according to Angle's classification.

The outcome of the whole of this part of the investigation was to show mandibular variation, but comparative maxillary constancy. Maxillary alveolar variation on a constant base, mandibular alveolar constancy on a variable base.

The angulations of the upper and lower processes, in very broad aspect, showed one of three occurrences: (1) Predominance of upper proclination; (2) Predominance of lower proclination; (3) Proclination of both alveolar processes.

Each of these eventualities could take place to a greater or lesser degree.

The figures show that extremes of proclination tend to affect one arch. Where upper and lower alveoli are equally proclined, it is to a lesser degree than that which can occur in either arch individually.

The next task was, therefore, to attempt to discover any of thc causes which condition these eventualities.

METHOD OF INVESTIGATION INTO FACTORS CONDITIONING SLOPE AND POSITION OF THE ALVEOLAR PROCESSES

It will be appreciated that a deal of information concerning angular and linear dimensions of the facial skeletons and alveolar processes had been collected and tabulated as part of the earlier experiments in this investigation.

These figures could be used to provide averages for each of the planes and angles measured. The averages could bc for the whole sample, or for any selected part thereof, and would provide sufficient information to enable geometrical construction of lateral skull diagrams. Any such diagram would be reprcsentativc of the collective features of any selected group, and would have the advantage of providing a two-dimensional pictorial record, suitable for comparison by superimposition, with other similar records. Since there were twenty-seven dimensional measurements involved in thc composition of each diagram, it will be appreciated that the formation of models, or averagc diagrams, based on collective information would be preferable to attempting comparative analysis of blocks of figures.

In order to ensure that the diagrams were accurate, the skeletal and alveolar dimensional information was re-tabulated into four blocks of figures, any three of which would give sufficient information to complete the geometrical outlines. Some angles and planes would, however, be automatically formed in the process. These were then mcasured and the results checked against the answers which were contained in the fourth block of figures. On those few occasions when an error exceeding 1° or 1 mm. was detected by this check, it was invariably found to be due to arithmetical or geometrical error and not to any failure of the multiple measurements to co-ordinate.

The purpose of this system was to enablc comparative analysis of collective groups of patients, selected either at random or on a basis of certain definite common clinical features, in order to discover any other complementary trends in their skeletal morphology. Confusing individual variations, which might be inconsistent and contradicted by opposing variables within the selected group would disappear through thc workings of averagcs. Any residual trends shown in the average diagram, or comparison of diagrams, could be significant. The use of these diagrams would, however, only isolate trends of possible significance, and true significance could only be claimed if average tendencics were still valid when applied to each individual and potential exception.

Fig. 7 will act as an example of the method. Three diagrams based on averages are shown. The full sample has been divided into three equal groups of 12 patients each, the basis for selection to a group being the possession of a high, average, and low maxillary–mandibular-planes angle. As can be scen, the diagrams rcvealed no significant variation in the alveolar slopes. The principal individual

difference between the groups was the feature for which they were selected in the first place.

Many similar comparative diagrams were prepared. Some, such as those in the above example, did not produce the hoped-for result. Negative outcomes can nevertheless be as helpful as positive ones in arriving at conclusions.

Similar diagrams were prepared of each of the Angle classifications, as represented by this sample, at three stages of development, namely 4 years of age, at the time of upper central incisor eruption, and at 10 years of age. Diagrams representative of the whole sample at similar ages were made, largely for the purpose of general comparison.

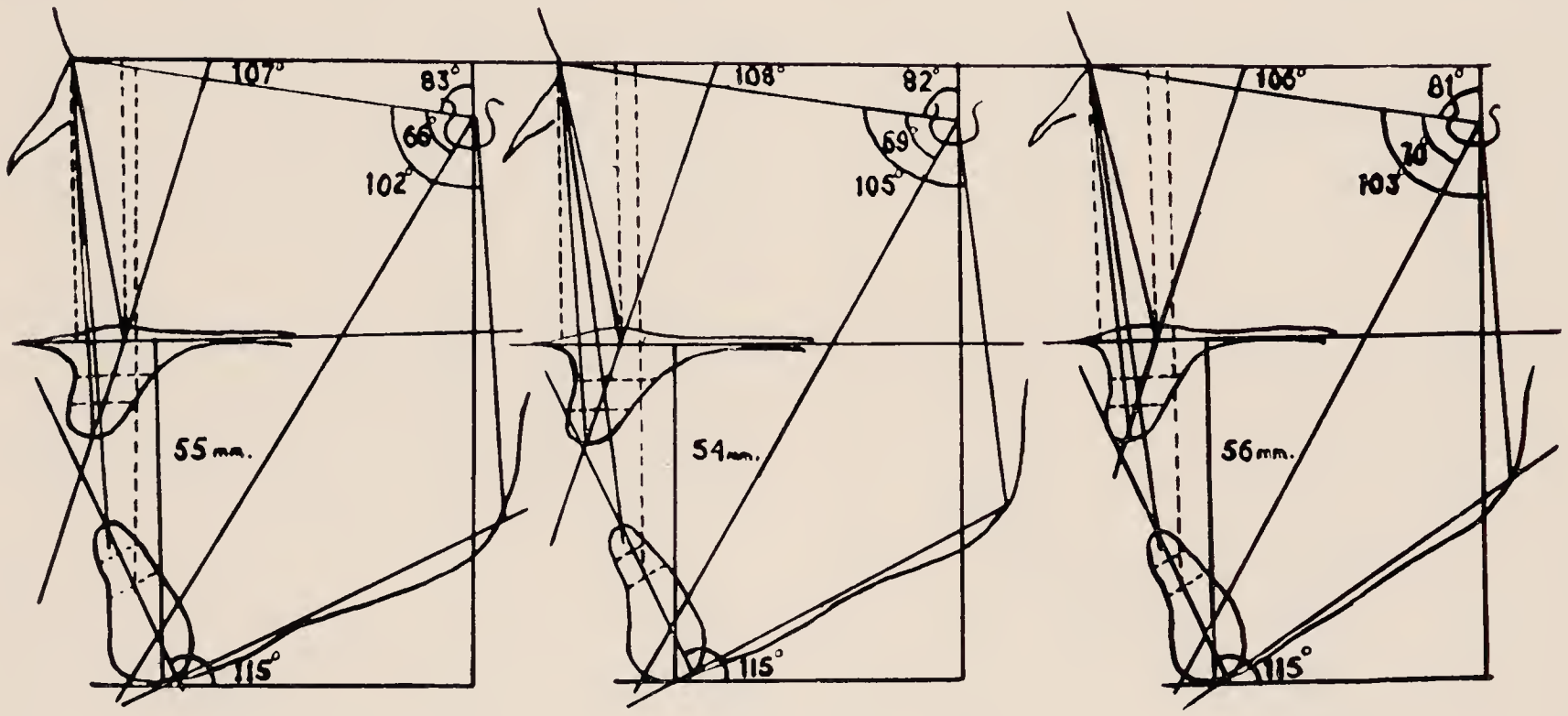
The principal problem at this stage, however, was to establish the possible cause underlying alveolar proclination or lack of it. To this end diagrams were constructed from averages derived from those selected groups of patients which showed:—

1. Above average proclination of the upper alveolus.
2. Below average proclination of the upper alveolus.
3. Above average proclination of the lower alveolus.
4. Below average proclination of the lower alveolus.
5. Above average proclination of both upper and lower alveoli.
6. Below average proclination of both upper and lower alveoli.

Assessment of alveolar proclination was against the horizontal as supplied by the Frankfurt plane. The diagrams were based on the figures obtained at the time of central incisor eruption for each person.

Initial comparison was always carried out on diagrams constructed from the average values of the features at the time of central incisor eruption. It was thought that by so doing the various patients' dental and chronological ages would be co-ordinated. Further diagrams based on chronological age were constructed only where the information they might give could be considered reliably supplementary to the first comparison.

Later, when it was found that correlations existed between the upper alveolar positions and certain proportional measurements of the facial skeleton, it was decided to supplement the diagrams of upper alveolar proclination and retroclination; the additional diagrams



MAX.–MAN. ∠=24°	MAX.–MAN. ∠=28°	MAX.–MAN. ∠=32°
SN–MAX. ∠= 9°	SN–MAX. ∠= 8°	SN–MAX. ∠=10°
SN–MAN. ∠=33°	SN–MAN. ∠=36°	SN–MAN. ∠=42°
SN UPPER ALVEOLAR CREST=80°	SN UPPER ALVEOLAR CREST=79°	SN UPPER ALVEOLAR CREST=78°
SN LOWER ,, ,, =78°	SN LOWER ,, ,, =76°	SN LOWER ,, ,, =74°

Fig. 7.—Geometrical facial diagrams produced from average figures of cases with low, average, and high maxillary–mandibular plane angles.

being those for the average age of 4 years and 10 years in each instance.

Comparison between the diagrams based on data derived from patients with above average and those with below average upper alveolar proclination showed that the latter possessed a greater facial height below nasion, and, in particular, a greater height anteriorly in the lower third of the face, than the former (*Fig.* 8).

MAXIMAL UPPER PROCLINATION			MINIMUM UPPER PROCLINATION		
CLASS I	3	CASES	CLASS I	4	CASES
CLASS II, DIV. I	6	,,	CLASS II, DIV. 2	4	,,
CLASS III	1	,,	CLASS III	2	,,
	10			10	

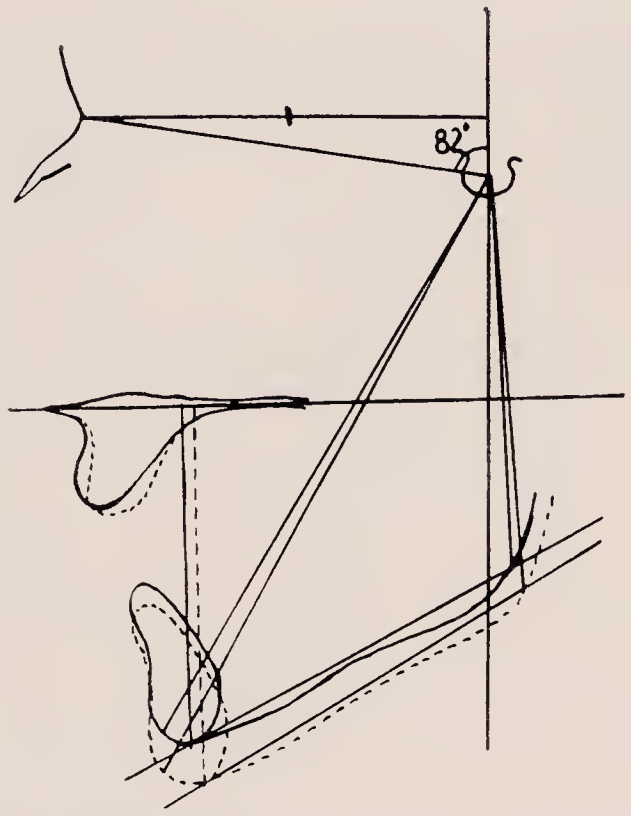


Fig. 8.—Superimposed average diagrams of 10 cases with maximum (solid line), and 10 cases of minimum upper alveolar proclination (broken line), at the time of incisor eruption. The upper face is identical in the two cases. Superimposition on the maxillary plane and centre of the nasion horizontal.

With regard to proclination of the lower alveolus, the diagrams showed that whereas upper proclination appeared to be associated with below average vertical height of the lower third of the face, lower proclination was associated with above average height in the same location.

The possible significance of these two findings had now to be confirmed against the test of each individual in the whole of the sample.

It was soon discovered that as far as the lower alveolus was concerned, the proclination associated with increased height was only an average tendency. The individual association was loose and there existed a number of wide exceptions and even reversals.

In the case of the upper, however, a high correlation between vertical height and degree of proclination for the individual was found. The graph (*Fig.* 9) shows height in millimetres of the lower third plotted against upper alveolar proclination in degrees for each of the individuals contained in the sample (measurements at the time of upper central incisor eruption). Those cases which possessed well

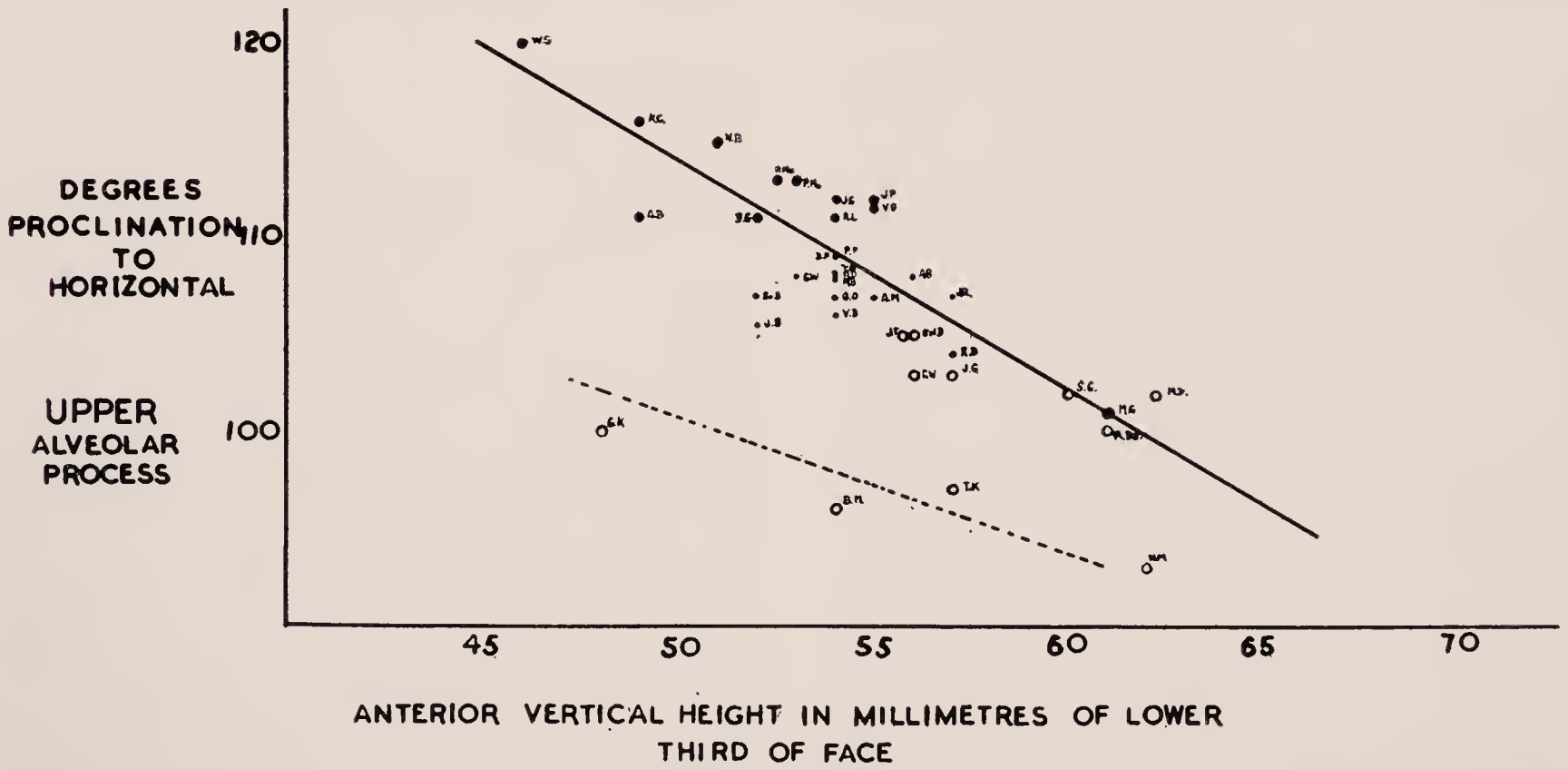


Fig. 9.—Graph to show the relation between the proclination of the upper alveolar process and the vertical height of the lower face.

marked upper alveolar proclination are shown on the graph by large black dots, those with markedly little upper alveolar proclination by small circles. This assists recognition against the plots of the average. Considering that this is a graph made from biological data, and that the plots are determined by straightforward measurement, making no allowance for differences in size of eaeh child, the line obtained is surprisingly straight. It is made no less remarkable by the fact that these measurements are for individuals, where averages play no part in reducing errors in tracing and draughtsmanship. The small units of measurement used and the scale of the graph are such that any variation, or error, of 1° or 1 mm. would displace a plot considerably across the paper.

The correlation between the slope of the upper alveolus and the height of the lower third of the face was not without exceptions. As can be seen, four plots fell outside the line of the remainder.

In case these exceptions were related to discrepancies in proportion between individuals, a rather complex arithmetical calculation was undertaken, aimed at reducing facial dimensions to unit proportion. The method was perhaps unreliable, but in any case no significant result was obtained.

The exceptions were made up of 3 cases of Class II, division 2 and 1 case of Class III. Study of the proportional changes in the developing parts of these exceptions showed that, in spite of different Angle classifications, they possessed an aetiological affinity. Class II, division 2 was plainly shown, during the course of this investigation, to be anything but a clinical entity. The factors which govern the development of normal occlusion are those which govern abnormal occlusion. The degree of abnormality will be dependent on the balance set up by the factors involved. One of these factors would appear to be the vertical height of the lower anterior third of the face.

The graphs and diagrams based on averages perhaps show this most clearly, but another test was applied.

A group analysis was carried out. Comparison in facial height was again made between all cases that showed above average upper alveolar proclination ($>107°$ to horizontal) and those that showed below average ($<107°$ to horizontal). This comparison was further subdivided on the basis of the angle subtended by SN to alveolar crest. This could be the normal (79°), or above or below that figure. Divided this way there were three paired comparative groups which took into consideration whether the alveolar crest was forward as a result of proclination or skeletal form. The groups were small, containing between 3 and 6 patients each. These segregations could be regarded either as three paired comparative groups or as six separate groups which could be compared by backward or forward reference, thus carrying comparison a stagc further. The details of this analysis have been omitted since the gencral outcome was the same as that indicated by the other methods, namely decreased facial height in the lower third brought about proportional increase in upper alveolar proclination. The only group which did not exactly adhere to this pattern was that which contained the exceptions mentioned previously. Although this dimension is an important factor in the establishment of upper alveolar slope there is yet more to be discussed if the exceptions are to be explained. The purpose of this tcst was to eliminate the possibility of direct skeletal influence on alveolar slopes.

Certain facts have come to light through the preceding stages of this investigation that appear to hold true for approximately 80 per cent of the subject material. From these it is possible to suggest an hypothesis whieh would form the basis of the conclusions to this paper. In the process of stating this hypothesis, further information will be appended from additional analyses of the information obtained from all stages of the investigation. The information so added will help to substantiate the basic hypothesis, and assist explanation of the exceptions mentioned in the preceding paragraphs. The additional information concerns rates of growth, direction of growth, and progressive changes in relative proportion and position of the facial structures, including the alveolar processes.

Before turning to the interpretation of the facts, a subsidiary observation might be helpful to the reader.

It is perhaps worth emphasizing that when alveolar proclination is mentioned this refers to above average angulation of these structures to the horizontal, regardless of skeletal pattern or other feature. Upper alveolar proclination has nothing to do with the presence of an overjet in this context. Many conditions of Class II, division 1 with overjets do not possess above average slope of the upper alveolus to the horizontal.

PART III: ANALYSIS OF PROGRESSIVE CHANGE IN THE ALVEOLAR PROCESS AND ERUPTING PERMANENT TEETH. AN HYPOTHESIS ON THE SKELETAL AND SOFT-TISSUE INFLUENCE ON THE DEVELOPING OCCLUSION

The importance of the slope and cross-sectional shape of the alveolar processes in guiding the teeth towards their points of eruption has already been stressed. The measurements and correlations so far mentioned have been associated with an attempt to obtain evidence upon which to found an hypothesis to explain how this alveolar pattern is imparted. This evidence is, however, inadequate, and before drawing conclusions it is necessary to refer to the tables and records once more, to ascertain when this cross-sectional shape is first acquired and whether, once acquired, it is in all dimensions thereafter entirely stable.

The anterior alveolar conformity as seen in the earliest radiographs of each child was strikingly similar to that shown in the last. The principal intervening change in cross-section was that already mentioned, namely the enlargement which occurs in some cases immediately preceding eruption. This was transitory, and once the permanent teeth had fully erupted and settled down into their final positions the bony enlargement subsided; thereafter, the processes presented a similar cross-sectional shape to that seen prior to enlargement. As to the positioning of the alveoli anteroposteriorly, a check was kept on the relationship of the upper and lower bases and crests to nasion at each stage of each patient's development. It was found that the average for all cases showed a forward movement of 1 mm. at the crests over the survey period (i.e., approximately 6 years, from 4 to 10 years). Angular and linear 'per perpendicular' measurements were both employed in this assessment, one acting as confirmation of the other. The change in position of the alveolar crests for individual cases showed that the small change, indicated by the average, was true also of individuals. The maximum change in relationship, within one person, was 4 mm. over a period of 6 years. The next largest was 5 mm. over 11 years. Since these latter measurements are individual, and beset by tracing inaccuracy, less reliance can be placed on them than upon group averages. Progressive changes in the position of the alveolar crests shown by group analysis will be dealt with later. It is safe only to conclude at this time that, once formed, the alveolar pattern and position change little. Further, it must be recalled that some patients surveyed were little over 2 years of age at the time of the first lateral radiograph, a third of the sample was under 4 years of age, yet it was just as apparent for these, as with the others, that even at such tender ages the alveolar pattern had already been established.

One must look, therefore, for the cause of alveolar conformity well before the age of 2 years. Little change can be expected to take place before, or after, permanent tooth eruption in the position of the alveolar crests unless natural development is interfered with, either by extraction or the superimposition of extraneous and artificial forces from appliances. The apparent immutability of the alveolus, once formed, and the early age at which it is formed must be added to the evidence implicit in the preceding parts of the paper, which can be summarized as follows:—

1. There is a eomparative constancy in the position of the upper anterior alveolar base relative to the nasion for all individuals.

2. There is comparative variability in the relationship of the lower anterior alveolar base to the same point through variation in the vertical and horizontal dimensions of the mandible from person to person.

3. The angulation of the upper anterior alveolar section upon its base tends to be increased where the lower third facial height is reduced anteriorly and proportionately within an individual.

4. The angulation of the lower anterior alveolar section upon its base tends to be increased by the opposite condition (namely, where the lower third facial height, anteriorly, shows above average increase proportionately to the remainder of the facial skeleton). The correlation for the lower is, however, far less constant than that for the upper.

When attempting to interpret these facts into a workable hypothesis one's attention is drawn first to the very early age at which alveolar pattern is established. The fact that this has occurred by 2 years of age would seemingly mean that if muscular influence makes a primary contribution it must be through the patterns, behaviours, and relationships of that musculature as they exist immediately succeeding birth.

It would appear likely that the alveolar processes acquire their shape and slope at this time during their vertical development. It is probable that if no soft-tissue influence existed, the processes would develop by surface apposition in a diffused heap, nearly vertically upon basal structures. (N.B.—The most vertical process measured was 91° to the maxillary plane.)

TONGUE INFLUENCE ON THE DEVELOPING ALVEOLAR PROCESSES

In order to understand better the differential influence of the tongue on the moulding of the alveolar processes against the buccal soft-tissue walls, it would be of assistance to recall certain antenatal events.

First, the tongue is a well-formed structure in the first few weeks of embryonic life and is related at that time to the primitive nasal cavity. It would not be unreasonable to assume that this primary relationship of the tongue to nasal cavity and developing palate exists, and is maintained, during the period when its attachments are forming. The relationship of the mandible to the tongue, regarded in this light, would be secondary and vary according to the degree and form of mandibular development at the time.

Anteroposterior under-development of the body of the mandible prior to birth would result in its anterior aspect being postnormally related to tongue and palate. This would necessitate compensatory variation in the tongue attachments, notably genio-glossus. The postnatal result would be that the tip of the tongue would be forward in relation to the developing lower alveolus compared to normal.

The opposite would be true of anteroposterior over-development of the body of the mandible at the time of attachment formation.

The second event, worthy of recalling, occurs about the twelfth week when the tongue descends from the nasal into the oral cavity, the immediate sequel of which is a change in direction of growth of the palatine processes from vertical to horizontal. Textbooks now ascribe this occurrence to rapid mandibular development, particularly vertically. Once descended, however, the tongue would remain initially in close relationship with the constituent parts of the developing palate. Some six months of continued development remain until the date of birth.

The position of the tongue at birth, within the surrounding oral structures, will be determined not only anteroposteriorly through the compensatory mechanism of attachment formation, previously described, but also by the degree and direction of vertical mandibular development which has taken place.

One of the characteristics of the apparent exceptions to the rule shown by the graph (*Fig.* 9) is the possession of a mandible, the body of which is not under-developed anteroposteriorly, but nevertheless gradually acquires a postnormal relationship to the maxillary structures through a vertical direction of growth which has a smaller forward component than usual (*see* p. 350, *April*).

At the time of attachment formation, in these cases, the size of the body of the mandible

would be normal, as also would be its relationship to the maxillary structures. No compensatory variation in the tongue attachments would therefore be expected in the circumstances. Since subsequently this mandible–tongue complex descends more vertically than usual it follows that the influence of the tip of the tongue on the upper alveolus would diminish unusually rapidly, whilst maintaining a normal influence upon the lower. This situation must be differentiated from the events associated with horizontal under- or over-development of the body of the mandible prior to birth.

It would not seem unreasonable to suggest that the tongue at birth has acquired in such a way through its attachments, in association with degree and type of skeletal development, a rest position and a relationship to the developing alveoli. These are the relationships primarily responsible, in association with the lips through muscular interplay, for the shaping of the processes. Coincident with these factors would be the matter of individual proportional variation of the tongue itself to oral volume. The fact that tongue-to-oral-volume ratio is usually believed to be higher at birth than later would add emphasis to the contention that this is the period when that structure would have the most influence upon the alveolar processes.

The influence of the tongue, subsequent to birth, upon the developing *lower alveolus* therefore will be dependent upon the relationship it has acquired to this structure through the control given largely antero-posteriorly by the attachments formed as described. The hyoid plays, metaphorically speaking, a very secondary role, akin the pot of a pot plant, determining site of origin but not influential to the position of the foliage.

The influence of the tongue to the moulding of the *upper alveolus* anteriorly will be dependent upon the relationship of the whole of this mandible–tongue complex to the base of the upper alveolus at the time of the latter's vertical development. In the case of the upper, the tongue's anterior–posterior relationship will vary with the direction of mandibular descent in association with the direction of maxillary growth. Its influence will also vary with the degree of this vertical descent. Since the tongue is attached to the mandible anteriorly, the smaller this vertical height anteriorly, the smaller the distance of the tip of the tongue from the upper alveolar base. The upper alveolus will be thereby either supported or actually moulded forward.

Before proceeding to add further substantive evidence it might be observed that the lower third facial height must be regarded for significance as a proportional measurement. This applies equally to other dimensions, the multiple of a suitable number of which would result in proportional volumetric readings. It would be pointless to assume that the whole hypothesis breaks down because an individual clinical example can be found that shows a lack of upper alveolar proclination in association with less than average facial height anteriorly in the lower third. This dimension could be below average, but when taken on a proportional basis with others, could well prove to be high for the individual concerned. The missing link in the equation was the matter of tongue volume. The figures and calculations suggest that this is for the most part constant from person to person.

There follows an analysis of certain facial dimensions, particularly those of the anterior height vertically of the middle and lower thirds of the face, as they pertain to the Angle classifications represented in the sample. Lateral skull diagrams, geometrically constructed from averages on the principle previously described, are submitted in support. These diagrams, and others, were used for multiple testing by superimposition of any one upon any other. Unfortunately it is not possible to demonstrate all these results in reasonable space. Nevertheless, the main purpose behind this analysis was to obtain evidence, as near as was possible, of the skeletal proportions as they existed at birth, and to demonstrate any change in balance that might occur thereafter.

Table VIII is a summary of these dimensions at 4 years of age, at the time of upper central incisor eruption, and at 10 years of age. The rates of growth in millimetres per annum have

been worked out for each dimension. Additionally, the anterior vertical height of the lower third has been expressed as a percentage of the total facial height below the nasion. The rates and percentages were also calculated for the individual as well as for groups.

Certain generalized comments might be made on these figures.

The earliest records provided, as near as was possible, an indication of the proportional decrease as the patient grows. This feature also held good for over 80 per cent of the individuals, but the remainder showed no decrease or even a fractional increase in the proportion. The maximum decrease shown by an individual amounted to 10 per cent over 6 years, the maximum increase to 2 per cent over a similar period.

It will also be seen that the rates of growth were such as to enable the Class II, division 2

Table VIII.—A Comparison between the Perpendicular Height from the Nasion to the Maxillary Plane and from the Maxillary Plane to the Menton at 4 Years, the Time of Eruption of the Upper Central Incisor, and 10 Years

(Slight adjustment has been made for early and late measurements where these were not available at the exact ages quoted; original figures in brackets. All measurements in millimetres.)

		Class I	Class II, Div. 1	Class II, Div. 2	Class III
At 4 years	Middle third vertical	39·9 (41·1)	41·1 (40·8)	44·2 (43·8)	41·2 (43·4)
	Lower third vertical	53·3 (54·1) (57·2 per cent)	49·8 (49·6) (54·8 per cent)	52·8 (52·2) (54·4 per cent)	48·5 (50·3) (54·0 per cent)
Total height		93·2 (95·2)	90·9 (90·4)	97·0 (96·0)	89·7 (93·7)
At upper incisor eruption	Middle third vertical	44·3	45·4	47·6	45·5
	Lower third vertical	56·1 (55·9 per cent)	53·0 (53·9 per cent)	54·8 (53·5 per cnet)	53·3 (53·9 per cent)
Total height		100·4	98·4	102·4	98·8
At 10 years	Middle third vertical	46·8 (48·7)	50·5 (50·1)	51·6 (52·2)	49·0 (50·3)
	Lower third vertical	57·9 (59·2) (55·3 per cent)	57·5 (57·2) (53·6 per cent)	60·0 (60·6) (53·7 per cent)	56·0 (57·7) (53·3 per cent)
Total height		104·7 (107·9)	108·0 (107·3)	111·6 (112·8)	105·0 (108·0)
Growth-rate in millimetres per annum	Middle third vertical	1·15	1·56	1·22	1·56
	Lower third vertical	0·84	1·30	1·20	1·44

situation at birth. It will be seen that those cases which eventually had a normal incisor relationship showed a higher percentage, up to the time of upper incisor eruption, for the lower third facial height anteriorly, than those cases whose incisor relationship was eventually abnormal. The latter showed a tendency for more vertical height in the middle third anteriorly in proportion to the lower. This was true of the individual as well as for averages.

It will be noticed that the percentage balance between the middle and lower thirds, measured in this particular way, tends on average to group to catch up and eventually overtake Class I in the matter of the lower third anterior vertical height given as a plain linear measurement.

Fig. 10 shows these events by superimposition of facial diagrams of each classification at three stages of development; the diagrams being drawn from averages produced from all relevant data. The vertical descent of the mandible anteriorly and the forward movement of the maxillary alveolus in Class II, division 2 is a notable feature of this comparison. Not unnaturally, these matters of

facial size, proportion, and development rates were looked into as they related to the cases which showed increased, and those which showed decreased, upper alveolar proclination. The 10 cases which demonstrated the most upper alveolar proclination were compared with the 10 which showed the least (*Table IX*).

Group I (maximal upper alveolar proclination) shows a lower average for the lower third than any of the Angle groups. Their average

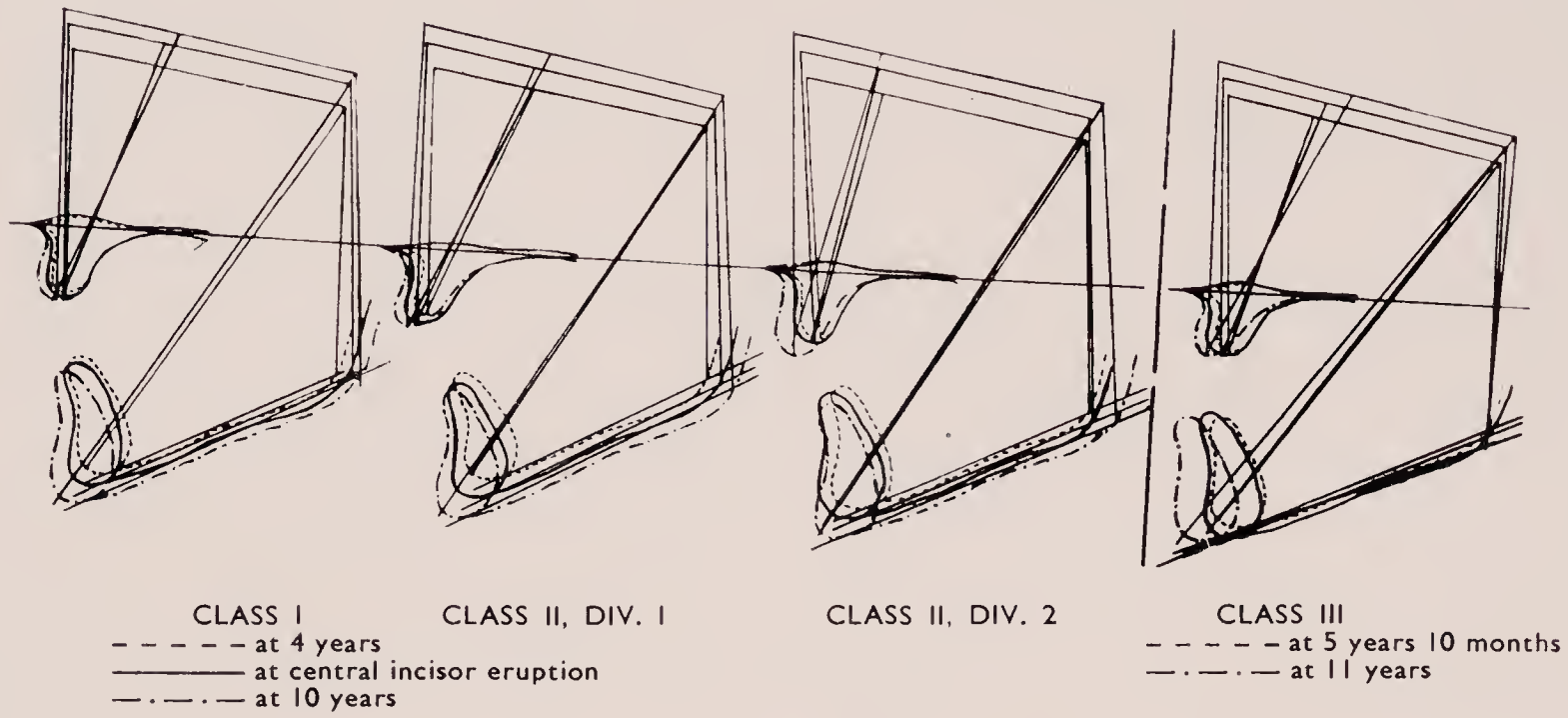

CLASS I
CLASS II, DIV. 1
CLASS II, DIV. 2
CLASS III
– – – – – at 4 years
——— at central incisor eruption
—·—·— at 10 years
– – – – – at 5 years 10 months
—·—·— at 11 years

Fig. 10.—Average facial diagrams for the principal types of malocclusion, superimposed at three stages in development.

Table IX.—Comparison between the Perpendicular Height from the Nasion to the Maxillary Plane and the Maxillary Plane to the Menton at Three Stages of Development in Cases with Above Average and Below Average Upper Alveolar Proclination

(Measurements in millimetres.)

		Above Average Upper Alveolar Proclination	Below Average Upper Alveolar Proclination
At 4 years	Middle third vertical	39·9 (40·6)	39·9 (41·1)
	Lower third vertical	49·2 (49·6) (55·1 per cent)	54·4 (54·8) (57·6 per cent)
	Total height	89·1 (90·2)	94·3 (96·2)
At upper central eruption	Middle third vertical	44·7	46·0
	Lower third vertical	51·9 (53·8 per cent)	57·3 (55·5 per cent)
	Total height	96·6	103·3
At 10 years	Middle third vertical	47·7 (49·1)	50·4 (50·8)
	Lower third vertical	54·4 (55·3) (53·2 per cent)	61·0 (61·2) (54·7 per cent)
	Total height	102·1 (104·4)	111·5 (112·0)
Growth-rate in millimetres per annum	Middle third vertical	1·30	1·60
	Lower third vertical	0·86	1·08

rate of increase for this dimension was 0·86 mm. per annum, nearly the lowest recorded for any group. The lower third vertical height expressed as a percentage of the total height below the nasion started at 55 per cent and fell to 53 per cent.

Group II (minimal upper alveolar proclination) shows a higher average for the lower third than any of the Angle groups. Their average rate of increase for this dimension parallel with the Frankfurt at the nasion. The difference between the measurements indicates the approximate distance of the genial tubercles behind the upper alveolar base (*Table X*). The angles at the nasion subtended by the same points against the sella-nasion plane are also included.

It can be seen from perusal of the foregoing table that where upper alveolar proclination is found, it is associated not only with a lack of

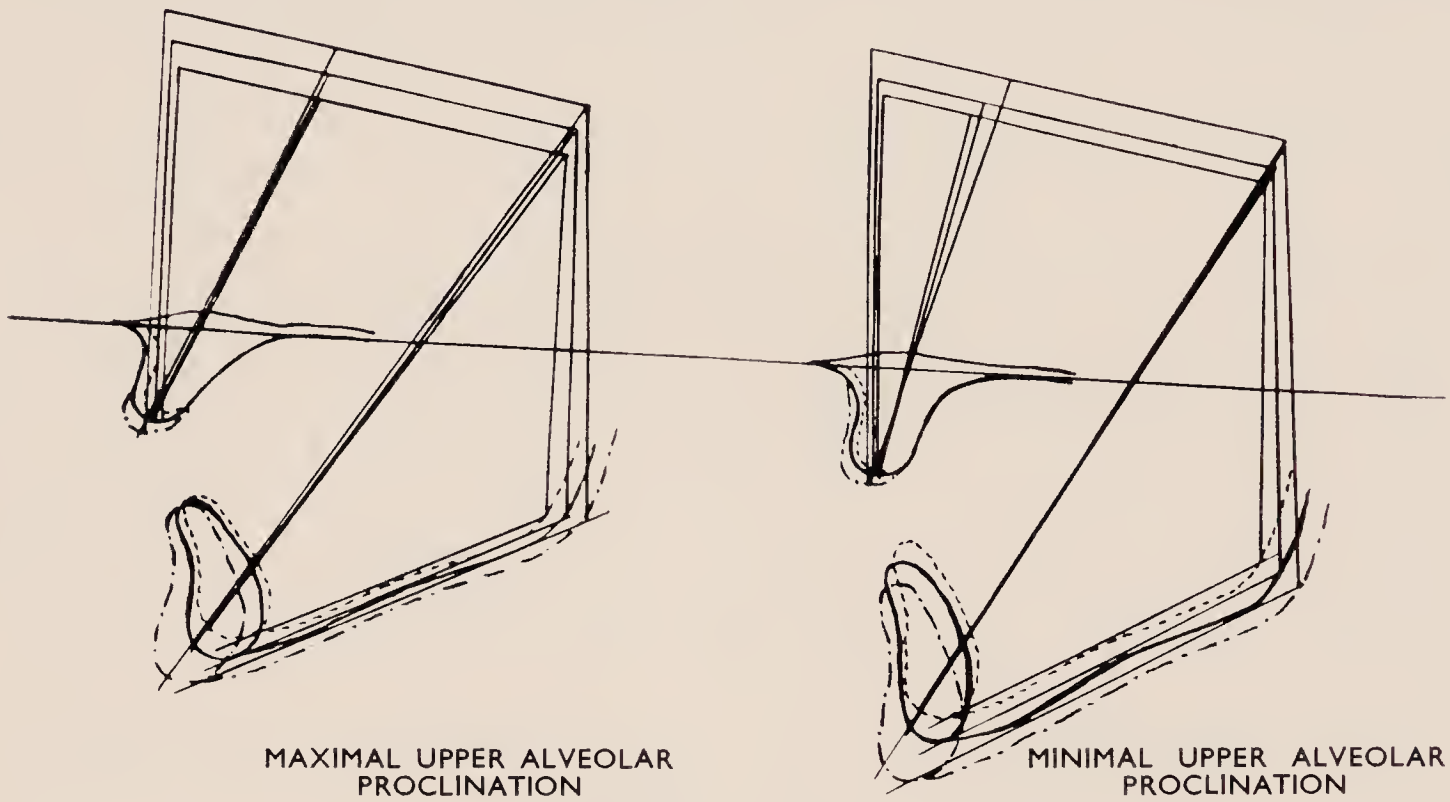

MAXIMAL UPPER ALVEOLAR PROCLINATION
MINIMAL UPPER ALVEOLAR PROCLINATION
– – – – – at 4 years
———— at upper central incisor eruption
— · — · — at 10 years

Fig. 11.—Contrasting average facial diagrams of cases with maximal and minimal upper alvcolar proclinations at three stages of development.

was 1·08 mm. per annum. The lower third expressed as a percentage of the total height below nasion started at 57·6 per cent and fell to 54·2 per cent, a high proportion being maintained throughout (*Fig.* 11).

Since the line selected to represent the facial height anteriorly of the lower third is affected by anteroposterior mandibular variations, and since this line has been referred to almost exclusively as referring to the vertical, some indication should be given of the pure horizontal relationships.

To this end a table has been prepared showing the distances behind the nasion of the upper anterior alveolar base and the innermost point of the anterior section of the mandible (genial tubercles) for all preceding groups. These have been measured by perpendiculars dropped from these points to a line drawn anterior vertical height of the lower third of the face but also with a more forward angulation of the facial structures anteriorly relative to the nasion than in those cases displaying the more upright upper alveolus.

It is also interesting to note that in Class II, division 2 conditions the distance between the approximate tubercle position and the upper alveolar base, measured through perpendiculars to the horizontal plane, increased, whereas in all other groups this distance decreased. This matter will be raised again.

The presence of a postural element together with a lack of reliable quantitative data makes the Class III figures subject to reservation.

The foregoing tables and diagrams assist interpretation of the probable proportional balance existing in various categories of

occlusion near the date of birth. They demonstrate the need for a correct early developmental balance to the establishment of normal occlusion and demonstrate that imbalance will produce abnormal occlusions.

10-year-old. Nevertheless, in the absence of orthodontic treatment, the alveolus will remain in its original position. Such matters will have a profound effect in assessing prognosis.

Table X.—A Comparison, by Angular and Linear Assessment, between the Estimated Position of the Upper Alveolar Base and that of the Genial Tubercles at Three Stages of Development

(The difference between the measurements represents the distance of the anterior attachments of the tongue behind the upper alveolar bone.)

	Angle at N against SN Plane						Distance in Millimetres Behind N Horizontal. 'Per' Perpendicular								
	Upper Alveolar Base			*Approximate Position of Genial Tubercles*			*Upper Alveolar Base*			*Approximate Position of Genial Tubercles*			*'Per' Perpendicular Distance of Tubercles behind Upper Alveolar Base*		
	4 yr.	6½ yr.	10 yr.	4 yr.	6½ yr.	10 yr.	4 yr.	6½ yr.	10 yr.	4 yr.	6½ yr.	10 yr.	4 yr.	6½ yr.	10 yr.
Class I	71·3°	71·9°	71·3°	69·5°	70·4°	71·0°	10·1	10·2	11·2	22·9	22·2	22·5	12·8	12·0	11·3
Class II, div. 1	69·9°	70·8°	70·4°	65·2°	66·5°	67·5°	9·4	9·5	10·8	24·9	24·2	23·1	15·5	14·7	12·3
Class II, div. 2	69·0°	70·0°	71·0°	65·0°	66·6°	67·7°	11·6	10·6	10·4	24·4	24·6	26·4	12·8	14·0	16·0
Class III	71·0°	70·5°	71·5°	70·2°	71·0°	73·0°	12·8	13·0	12·6	20·4	15·5	14·0	7·6	2·5	1·4
Above average upper alveolar proclination	71·5°	71·4°	71·6°	68·1°	69·1°	70·1°	9·4	9·2	10·4	22·1	20·9	20·6	12·7	10·7	10·2
Below average upper alveolar proclination	70·4°	71·0°	71·1°	66·9°	66·5°	69·1°	10·9	10·2	11·1	25·9	24·9	24·7	15·0	14·7	13·6

They also indicate, through the figures for growth rates and percentages of the anterior facial heights, that there is a change in proportion in this region as the patient grows and that this varies from one individual to the next. *This, in spite of the fact that horizontal and vertical angular skeletal measurements remain the same.*

It would seem, therefore, that although the skeletal form or shape remains the same, the relation between the linear distances or areas of lateral radiographs at successive ages will change. The implications of this will have increased significance if we consider that the same applies to the third dimension not shown by lateral radiographs. Because of these changes in proportion— and also proportional changes between hard and soft tissues, as, for example, the relatively smaller size of the tongue in the older child—the original aetiological factor responsible for moulding the alveolus may no longer be present in the

LIP INFLUENCE ON THE DEVELOPING ALVEOLAR PROCESSES

In order to gain more information with regard to the soft-tissue balance between tongue and lip, as it might pertain to differing periods of development in differing occlusions, a group analysis is submitted, as promised earlier. It was thought that the alveolar processes, and the permanent incisors, from the point of eruption onwards, would reflect lip–tongue balance in terms of a progressive response in one direction or another.

The Angle classifications were analysed at the three periods of development, as used throughout this paper. Since interest centred on soft-tissue balance, Angle's Class II, division 1 was subdivided into groups displaying lip competence and incompetence.

The progressive changes in position of the alveolar processes refer to the whole of the development period from 4 to 10 years of age. The changes in tooth position relate only to

the post-eruptive behaviour, since they would not be directly influenced by the musculature whilst still within bone.

The measurements used were both linear and angular as obtained at earlier stages of the investigation.

The alveolar measurements included the angles, sella–nasion–alveolar crests, sella–nasion–alveolar bases, together with the long axis angulation against SN plane or mandibular plane in the case of the lower arch. The accuracy was checked by the inter-alveolar angle and by the perpendicular measurements to the horizontal plane (Frankfurt).

The upper and lower incisors were dealt with by a similar system as far as their long axes and interaxial angles were concerned. The incisal tips and apices took the place of the alveolar crests and bases when subjected to the perpendicular and angular tests to the horizontal, SN, and mandibular planes.

The various systems of measurement gave slightly varying quantitative interpretations, but when each set of figures was regarded from a proportional standpoint the impression gained was always the same.

Table XI is an amalgamation of all information on the progressive changes as shown by the averages for each group. This and other information collected was sufficiently comprehensive to indicate the average pivotal points of the incisors as these change direction during eruption.

Table XI.—Positional Changes, on an Angular Assessment to the SN Plane, of the Alveolar Processes over the Full Period of the Survey, and of the Central Incisors from the Point of Eruption

	Alveolar Processes								Central Incisors					
Upper	*Long Axis to SN Angle*		*Degrees Change*	*SN-Alveolar Crest Angle*		*Degrees Change*	*SN-Alveolar Base Angle*		*Long Axis to SN*		*Degrees Change*	*SNI Angle*		*Degrees Change*
	Early average	Late average		Early average	Late average		Early average	Late average	At eruption	Late average		At eruption	Late average	
Class I	99·7°	103·7°	+4·0°	79·4°	80·0°	+0·6°	71·3°	71·3°	99·6°	101·6°	+2°	78·3°	83·2°	+4·9°
Class II, div. 1 (lip incompetence)	104·1°	106·5°	+2·4°	80·5°	80·4°	−0·1°	71·3°	71·4°	99·8°	108·6°	+8·8°	78·0°	84·8°	+6·8°
Class II, div. 1 (lip competence)	102·3°	103·2°	+0·9°	78·5°	78·3°	−0·2°	68·8°	69·7°	96·7°	102·2°	+5·5°	77·0°	82·1°	+5·1°
Class II, div. 2	92·4°	95·6°	+3·2°	74·8°	78·2°	+3·4°	69·0°	71·0°	93·8°	78·4°	−15·4°	73·4°	76·8°	+3·4°
Class III	99·0°	105·6°	+6·6°	77·0°	78·3°	+1·3°	71·0°	71·0°	94·6°	98·6°	+4·0°	75·3°	80·6°	+5·3°
Lower	*Angle to mandibular plane*								*Angle to mandibular plane*					
	Early average	Late average							Early average	Late average				
Class I	89·8°	97·3°	+7·5°	77·2°	78·0°	+0·8°	–	73·8°	78·3°	90·0°	+11·7°	75·0°	80·2°	+5·2°
Class II, div. 1 (lip incompetence)	87·0°	84·8°	−2·2°	73·1°	73·6°	+0·5°	–	72·8°	76·0°	90·2°	+14·0°	71·4°	78·4°	+7·0°
Class 11, div. 1 (lip competence)	87·6°	83·2°	−4·4°	71·3°	71·7°	+0·4°	–	70·6°	77·1°	91·1°	+14·0°	70·2°	76·0°	+5·8°
Class II, div. 2	86·6°	88·4°	+1·8°	71·6°	72·2°	+0·6°	–	71·0°	77·4°	90·2°	+12·8°	69·6°	74·2°	+4·6°
Class III	87·3°	86·3°	−1·0°	79·0°	82·0°	+3·0°	–	77·1°	80·0°	88·3°	+ 8·3°	79·0°	83·3°	+4·3°

Several interesting observations can be made from this comparison, firstly as it relates to the alveolar processes.

The position of the upper alveolar bases in relation to the nasion showed the expected lack of variation from category to category. It is interesting to note that those cases of Class II, division 1, diagnosed as having lip competence gave a position for the upper alveolar base, which was retracted behind the

nasion, in similar manner but lesser degrec to Class II, division 2 or Class III cases, contrasting with those cases showing lip incompetence. Could there be somc progressive association hcrc?

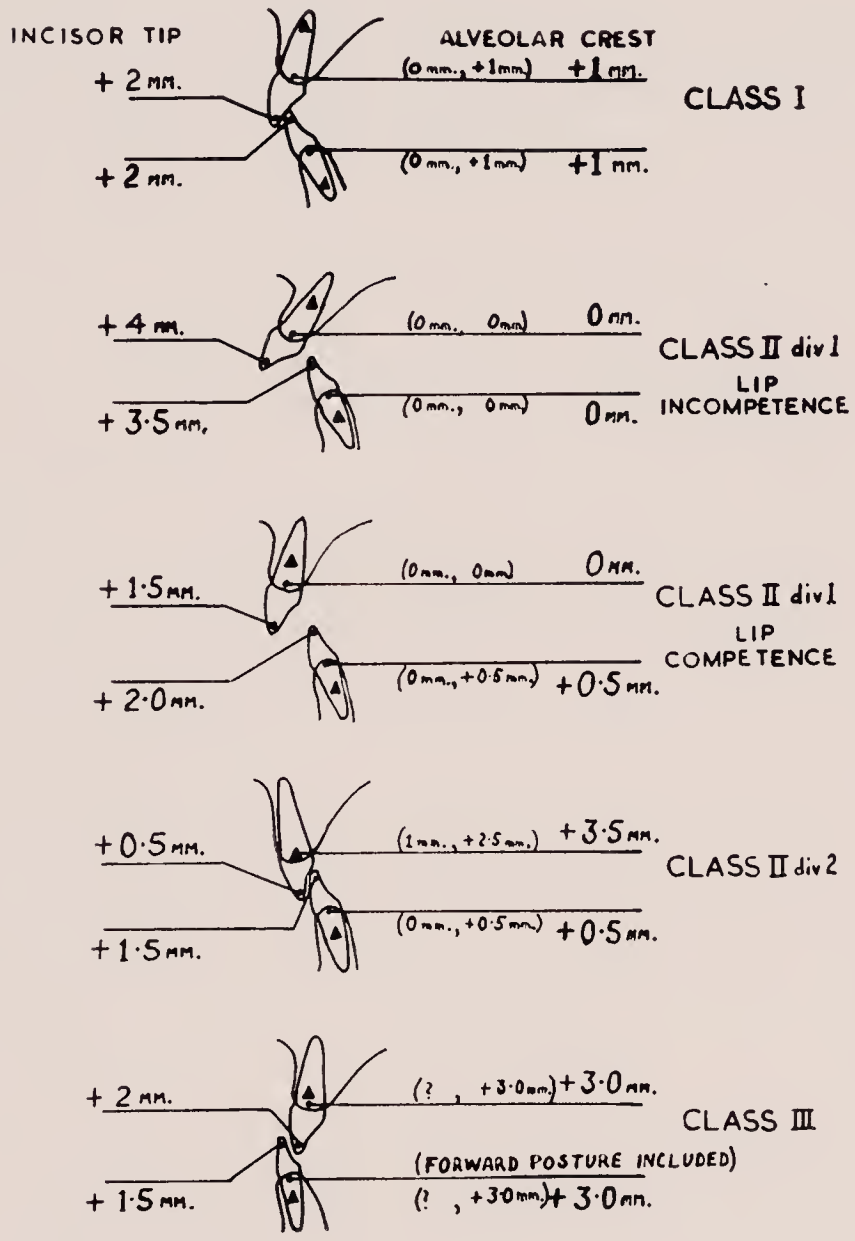


Fig. 12.—Diagram to show the changes in position of the alveolar crest during the period under review, and of the incisal edges from their eruption. The large figures show the overall movements of incisor tip and alveolar crest, while the small figures in brackets show alveolar movement before and after incisor eruption.

It will be seen from *Fig.* 12 that thc progressive changes that took place in the angulation and positions of the alveolar processes and incisor teeth werc of vcry even distribution in Angle's Class I. The alveoli at their crests, and the incisors at their tips, moved forward an equal amount in both arches in relation to the nasion, the incisors pivoting by simplc tilting about their apical third.

This can be regarded as typical behaviour where all factors conccrned are proportionately well balanced, and can therefore be used for comparativc purposes with other classifications where factors are known in be in imbalance.

One surprising finding was that the upper alveolar process of Class II, division 2 showed an above-average tendency to move forward in relation to the nasion. All measurements showed this, and it was true equally of the individual case. This tendency is progressive, and not associatcd with the time of tooth eruption. There was some indication that the movement was related to a general growth phenomenon in the middle-third structures and not related to lip–tongue balance. Whatever the cause, however, it would mean that if this bony section moves forward, whilst the crowns of the contained teeth arc rcstricted to less forward movement by, for example, the lower lip, then an cxplanation has been found for the slow continuous labial movement of the upper central incisor apices, in these particular conditions. Stabilization of the incisal tips is derived from one arch, forward motivation to the root from the other.

A contrast to this situation is provided by the Class II, division 1 group with lip incompetence. Here both upper and lower alveoli were proclined, but no movement took place at the crests on average during the survey period. It can be inferred that, in these instances, the tongue has had no difficulty, against impoverished lip control, in preserving maximum space required for function, through alveolar moulding, at the time of the latter's vertical development, and hence bcfore the time of the earliest radiographs. Alveolar proclination has already occurrcd during the primary phase. Thereafter, because the lips are of a pattern incapablc of retractive forces, and because the tongue would have no need, no capacity, and no inclination to make further functional demands, the lack of movement at the alveolar crests is explained.

The tongue has herein been referrcd to as 'preserving' space and 'moulding' the alvcolus. These words have been used advisedly. There is every indication that the tongue affects the alveolar processes through its physical presencc and over a limited zonc of

normal, or occasionally abnormal, activity. In this sense very mild active forces would be produced, but it must be stressed that the tongue never 'pushes' to an extent that impinges on a patient's consciousness. The tongue moulds the alveolar processes during their vertical development and guides the teeth during their eruption. It can obstruct either event by its physical presence, but will avoid situations calling for the conscious production of active forces. This matter will again be raised in reference to the behaviour of the teeth on eruption into the soft-tissue environment.

Before proceeding it might be advisable to clarify what appears to be a contradictory measurement in *Table XI*. This is the misleading impression of alveolar proclination taking place at the time of transition from deciduous to permanent dentition conveyed by the alveolar long axes measurements. This is associated with the method of assessing the long axis, described earlier. Alveolar enlargement, principally buccally, which precedes incisor eruption has the effect of altering the central plots from which the long-axis line is drawn. This results in a reduced angle to the horizontal or SN plane. It must be noticed that the alveolar crest positions do not alter during the process, i.e., no proclination of the processes takes place.

Finally, there remains the need for an analysis of the movement of the incisor teeth from the point of eruption until such movement becomes imperceptible. The tables and diagrams present no particular surprises on the surface. There are, however, issues involved which are not immediately apparent.

Since the alveolar processes have been moulded by the tongue against the lip barrier, their position and shape are demonstrative of the early muscular pattern and balance. Since, also, they guide the unerupted tooth towards the point of eruption, it follows that this will also be near the point of equilibrium. The crowns of the incisors, however, normally erupt more vertically than their final position, and sometimes lingual to the alveolar crest, and are guided forward to their final positions through the presence of the tongue, during their continued eruption. The crowns of the teeth are moved forward, whilst the roots move through bone without disturbing the position of the alveolar crest. This forward movement of the incisor crowns will be limited in extent by several possible factors.

In the upper arch the incisors may erupt into positions where their crowns are within the zone of tongue activity or, in some cases of overjet, the lower lip. They will be tilted forward until these forces are expended, or until prevented by the control of the lips. If either the lips, or contact between root and buccal alveolar wall at the neck of the tooth, should stop crown movement before tongue influence is expended, the sequel is continued palatal movement of the apex. The possible cause of the slow labial movement of the upper incisor apices, occurring in Class II, division 2 conditions, has been dealt with elsewhere. Lastly, it should be observed that, in some instances, alveolar guidance will be sufficient of itself to the attainment of the equilibrial position, the teeth on eruption being directly affected by neither tongue nor lip, but only indirectly through the prior effect of the musculature in shaping and positioning the alveolus.

The lower arch situation presents a wider range of possibilities to the limiting of the continued labial movement of the incisor crowns. In addition to the lips, or buccal alveolar wall, obstruction to the forward movement of the crown can occur from the palatal soft tissues or the opposing teeth. If one of these obstructions is met before tongue influence is expended, tooth movement may continue not in a labial direction at the crown but in a lingual direction at the apex. (This occurrence is more frequently seen in the lower than the upper arch.) The lingual apical movement will cease, either when muscular equilibrium is reached or when contact is made between the apex and lingual alveolar wall.

Attention is now drawn to the role of the alveolar pattern in restricting post-eruptive incisor movement (*Fig.* 13). This factor is most readily demonstrated in the lower arch of cases with incomplete overbite, notably in

Class II, division 1 cases. Here the lower incisors, erupting vertically and lingually as usual, describe their forward arc until the necks of the teeth reach the superior aspect of the buccal wall of the alveolus. At this point

STAGE 1:
Lower incisor pivots about a point within crown. Open apex moves labially.

STAGE 2:
Initially on eruption lower incisor pivots about apical third of root.
Principal movement at incisal edge labially.

STAGE 3:
Forward crown movement stemmed when lower incisor reaches buccal alveolar wall.
Principal movement thereafter, in the presence of tongue activity, is of the apex lingually.
All movement stemmed when root reaches lingual alveolar wall.

Fig. 13.—An example of alveolar control over lower incisor position.

all perceptible forward movement at the neck ceases, but, in the presence of continued tongue activity, lingual movement of the apices proceeds until these, or some aspect of their roots, contact the lingual alveolar wall. All rapid movement then ceases abruptly. It was noticed that the approach of the teeth to this position was rapid, making the sudden cessation of movement all the more striking. Noteworthy, also, was the fact that the lips did not necessarily have to be competent for the above events to hold true. There existed, in such circumstances, apparent opportunity for the crowns of the incisors to be moved farther labially, yet this never happened, not even where 'tongue thrust' was also a feature.

Two conclusions stem from these observations. First, lip competence, or the ability to form an anterior oral seal, is but one aspect of lip control. Failure of lip seal at the red margins often permits more proclination of the teeth, but there remains their comparative degree of restraining influence, above and below, overlying areas of the alveolar processes. The structural form of the lip muscles is such that they could apply varying stricture in different individuals; more at the red margin and less elsewhere; less in the upper than the lower, etc., and vice versa. Lip influence at the time of initial alveolar development could dominate that of the tongue, restraining the lower alveolus sufficiently to cause obstruction to the tongue. This the tongue would avoid by subconscious reflex. The resultant alveolar pattern would appear narrow in cross-section and be moulded lingually from its base.

The second conclusion arises from the above mentioned problematic behaviour of the lower incisors in conditions of incomplete overbite. Once these teeth are angled across the lower alveolus, contacting the buccal plate at their necks and the lingual wall with one aspect or another of their roots, the tongue would be presented with a formidable task should further labial movement of the crowns be a requirement for normal function. In order to move the incisors further it would need to produce a pressure stimulus sufficient to resorb the buccal or lingual plate or the roots of the incisors. Alternatively, it would need to move forward the teeth and alveolus against control derived from the fold of the lower lip. It is submitted that the tongue could never produce a sustained effort sufficient to achieve any of these alternatives quickly without arousing the patient's awareness. Tongue stimulus is always at subconscious level. What, therefore, would be the result if these teeth were, on occasion and in the circumstances, to be stabilized by the control imparted through the alveolus in such positions that their crowns obstructed the normal functions of the tongue? It is submitted that in these circumstances, particularly when associated with short anterior tongue attachments to be expected in instances of prenatal horizontal mandibular under-development, an adaptive posture and/or behaviour of the tongue must be induced. The gyrations of the

tongue which follow would be due to the patient's subconscious endeavour to produce the best function with the minimum discomfort and, consequently, effort that these circumstances allow.

To those who would argue that the crowns of the lower incisors are always in true muscular equilibrium, and that the tongue never attempts their further labial movement, there is ample evidence to the contrary.

Root resorption is often seen even at the time of orthodontic treatment in these conditions and it is probable that incidence increases with age. In the older patients of 20 years and upwards there is a deposition of bone over the apices on the lingual aspect of the alveolus. The enlargement is palpable clinically and recognizable on lateral radiographs, whether or not orthodontic treatment has been administered. Lastly, in the still older patient, loss of the buccal alveolar wall at the necks of the incisors is common. These present as periodontal problems.

The above is one of three possible inducements to abnormality of tongue behaviour through environmental imbalance, and concerns the horizontal dimension. The other two are outside the scope of this paper and concern reduced vertical and lateral dimensions of the oral cavity which result from skeletal form. These must be added to those tongue behaviours which are atypical as a result of extrinsic or intrinsic deformities, or impaired motor innervation of the tongue.

Although the observations on soft tissues must be regarded as conjectural, they were nevertheless prompted by the figures obtained from this investigation and their comparative analysis. Through the ideas which prompted, it was possible to pick out the cases within the sample that showed abnormality in tongue behaviour without prior reference to the patients or the written records.

SUMMARY AND CONCLUSIONS

The shortcoming of this work from the standpoint of scientific proof lies in the restricted size of the original sample, which, when subdivided, was sometimes inadequate to destroy the element of chance.

Nevertheless, although often examined in sections, the evidence produced was used to build up an hypothesis upon the relative interaction and importance of some main factors governing malocclusion as a whole. The hypothesis submitted has been based on evidence found applicable to at least 70 per cent or higher for the whole sample. Lesser correlations were not used as a basis for support, but were considered as a potential exception wherever this appeared to be the case.

The subject material has been exhaustively measured and elaborate precautions taken to ensure optimum accuracy. Unfortunately, original tracing and radiographic accuracy cannot be easily demonstrated. Tracing work was repeated twice, sometimes four times, to assess the margin of error. The resultant figures were highly satisfactory when compared with published figures for the same type of exercise. This was gratifying to the author, but the implication to others of a close correlation between two sets of tracings could be no better than that the author was able to make the same degree of grotesque error twice in succession.

Again, statistical tests for significance test only the figures produced, not the authenticity of the original material or the accuracy of method by which those figures were produced. These thoughts serve as an introduction to the summary of deductions which follow in chronological order:—

1. Attachments to the tongue are formed well before birth whilst the tongue itself is closely related first to the primitive nasal cavity and, later, to the developing palate. This primary relationship of the tongue in association with variations in skeletal development, particularly that of the mandible, accounts for compensatory variation in the attachments.

2. At birth the tongue has acquired a resting position and a relationship to the developing alveolar processes. It is the skeletal and soft-tissue patterns and relationships at this period that are primarily responsible for alveolar moulding.

3. The cross-sectional shape of the alveolar processes are the result of the stimulus of the

tongue which moulds these structures against the barrier of lip or cheek. This stimulus, however, never reaches conscious level.

The lower developing alveolus anteriorly will be variably affected according to the relationship that the tip of the tongue has acquired to that structure through the medium of its attachments, particularly genioglossus. This implies variation largely horizontally.

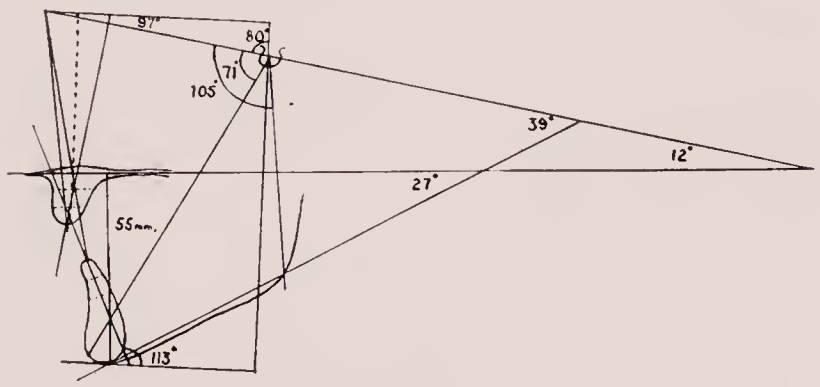


Fig. 14.—Average facial diagram constructed from the data of the four 'exceptions' in *Fig.* 9.

The relationship of tip of the tongue to the upper alveolus anteriorly will vary horizontally through the direction of the descent of the mandible during growth and the degree of vertical distance acquired anteriorly between the mandibular attachments and the base of the upper alveolus.

4. Once formed, the alveolar processes remain very stable in all dimensions during the course of all succeeding natural events. Their cross-sectional shape and cubic capacity in relation to the size and position of the developing permanent teeth determine the position of the latter on eruption.

5. Once erupted, the permanent teeth settle to positions of equilibrium amongst themselves and within environmental influences. This equilibrium need not be through muscular interplay on the crowns. Tooth position can be determined through the shape of the alveolar process produced by prior muscular effect, notably that of the lips. This particularly refers to the lower incisor region, where the conflict of certain variations in anterior tongue attachment and the position of the lower incisor crowns could be an inciting cause of adaptive behaviours on the part of the tongue in pursuit of function.

6. Throughout the growth period the skeletal shape, as indicated by angular measurements, remains comparatively unaltered. There is indication, however, that proportional volumetric changes within that shape occur and that these are beneficial in varying degrees to prognosis for orthodontic treatment.

7. Malocclusion is, therefore, one disease, not four separate ones as might be inferred from Angle's classification. The factors which determine normal occlusion are those which promote the abnormal, the difference lying in the degree of balance or imbalance existing between them at the time immediately preceding and succeeding birth.

8. There remain the apparent exceptions as demonstrated in the graph (*Fig.* 9). These cases have a lack of upper alveolar proclination greater in degree than that to be expected from the factor of anterior height of the lower third of the face and attendant implications alone.

They demonstrate, however, a number of features, all of which would contribute towards the lack of upper alveolar proclination (*Fig.* 14).

a. The tongue position at rest is normal in relation to the *mandibular* structures. This is due to the normality in the size of the body and its relationship to the maxillary structures during the period of attachment formation. Thereafter, the mandible–tongue complex descends vertically away from the maxilla in a manner which causes the relationship between the genial tubercles and base of the upper alveolus to tend to diverge; convergence being the normal event.

b. The vertical development of the mandible occurs at a rapid rate, the tip of the tongue being carried away from the developing upper alveolus.

c. The lips are competent to the fullest degree.

d. The tongue itself may be a broader structure in association with the broader face and in extremes can promote a buccal overjet rather than one anteriorly in the upper arch.

These features are seen independently in other conditions of malocclusion, but their effect is there masked by the presence of other variables allowing for, or producing, opposing effects.

Therc are many clinical impressions which are gained from a close survey such as this which cannot be enlisted as supporting evidence through lack of space and difficulty in description. Nevertheless, it is hoped that sufficient evidence has been put forward to demonstrate the plausibility of the contentions, and enough contentions to set in better perspective some of the factors in the aetiology of occlusion.

Finally, it was the author's purpose to gain perspective in thesc matters for his own benefit. The work is incomplete, and the views and conclusions are therefore his and do not necessarily coincide with those of other authorities or institutions, not even those with which he is associated.

DISCUSSION

Mr. B. C. Leighton, opening the discussion, said he believed he was right in inferring that the following conclusions were drawn from this study:—

1. Alveolar contour played an important part in determining where a tooth would erupt (labio-lingually).
2. As there was little change of contour over the age period studied, it was deduced that this was similar at birth.
3. The contour of the alveolar process was under muscular influence.
4. Therefore museular control operated to determine tooth position before eruption, and even as early as at birth.

Mr. Leighton said his own experience in his research *up to the present time* gave him no cause to dispute most of these conclusions. He did, however, have the impression when observing the effect of arresting an obvious eause of alveolar deformity, sueh as finger-sucking, that the mechanical distortion lasted no longer than the mechanical foree.

He had been most disappointed to find how littlc was the correlation between obvious variations of morphology at birth and subsequent malocclusions. This was particularly so of even an attempt to correlate the horizontal shape of the alveolar contour at birth and at $3\frac{1}{2}$ years of age; often there was very little correlation. Most of this ehange took place in the first 6 months of life, and Mr. Leighton said he would doubt the wisdom of projecting straight lines of development between the ages of 4 and 10 years back to birth.

To comment on the sample itself, although Mr. Fletcher had quoted quite a lot of averages, when he dealt with Angle's Class II, division 2 and Angle's Class III there were only 5 individuals in each of those classes. The age ranges of the different groups varied, especially that of Class III. He had quøted a mean age, before incisor eruption, of 4 years. This represented an age range of 2 years 4 months to 7 years—quite a big range. Mr. Leighton wondered if it was quite fair to group these children together.

He could see advantages in grouping the middle group together; at the time of incisor eruption they were obviously at a similar stage of development. But the initial stage was very diffcrent, and if it differed from one Angle's class to another it might complicate results. Was it wise to group these children together in groups? Should they not havc been treated as individuals?

Sccondly, Mr. Leighton said he had been a littlc surprised to see Mr. Fletcher relating lower incisor position to SN plane, and particularly to the nasion. Hc believed Mr. Fletcher had related it to the other planes, maxillary and mandibular, but he had made very littlc of its relation to the mandibular plane, particularly when dealing with changes of position at apex and crown. He would ask, were his findings confirmed when he related the lower incisor to a eo-ordinate of the genial tubercles to the mandibular plane?

Thirdly, Mr. Leighton said he was sure Mr. Fleteher was quite right in asserting that the periosteum limited tooth migration; this was one of the most interesting observations he had made.

It was interesting to recall in this connexion a paper by Imre Kovacs on the subject of root morphology, which he attributed to the encountering of such struetures as the antral floor or inferior dental canal. He had used this as an explanation of the shape of roots in various individuals. Mr. Leighton said he had found it a most convincing paper, and had seemed to find some more confirmation of it in Mr. Fletcher's paper.

Fourthly, as regards the post-eruptive phase, Mr. Leighton said he could offer a little confirmation here, that the labial inclination of incisors after eruption did take place quite rapidly. He had had several cases where this had occurred, whereas lingual inclination, when it oecurred, could be extended over a period of several years.

Mr. C. D. Parker said that one thing had crossed his mind after hearing about this constant relationship between the tooth and the alveolus and eruption: was this an indication for early treatment? Would it be easier to mould the alveolus just before the eruption of the pcrmanent incisors rather than reposition the ineisors after they had erupted?

Mr. L. H. Russell wanted to question Mr. Flctcher's use of the template of the shape of the incisor to go back to the developing incisor. The root–erown angle could be different during the development of the tooth shape, as the tooth did come into the influence of the oral tissues, in particular with regard to Class II, division 2 type of mouth.

Mr. G. H. Steel asked what did Mr. Fleteher trace when he traccd the outline of the maxillary–mandibular alveolus?

Mr. K. E. Pringle said he had had the eonception over a number of years that one should not think so much of tongue activity in relation to the lower ineisors as the question of tongue size and tongue growth. With upper incisors it was tongue activity—where it was placed during swallowing.

Mr. L. H. Russell said, coming back to thc shape of the alveolus, as traced, could this bc done on tomographs rather than looking through the whole of the skull and imagining where the outline was?

Mr. D. M. Menezes said it was usually quite easy to take lateral skull radiographs of adults and of children abovc the age of 12 years.

He wondered how Mr. Fletcher overcame errors when he took radiographs of children from the age of 2 years, onwards, as he had done? Did he use the same technique, and did he make any modifications with reference to exposure, timing, and so on?

Mr. G. G. T. Fletcher, replying to the discussion, said in regard to the points raised by Mr. Leighton, that the numbers of Class II, division 2 and Class III conditions were small and it would be wrong to draw too dramatic conclusions. Nevertheless, the main purpose of the investigation was to draw conclusions as to possible aetiology in general from the whole sample. Analysis of the subdivisions supported the principal deductions. The attempt to explain the slight differences between groups was permissible and based on the figures obtained. Confirmation of the theories would have to wait for further investigation.

As to the admissibility of projecting back by straight lines from 4 years to birth, this was an assumption covering a period of ignorance. The theories had at least been prompted by the analysis and this was no worse than theorizing without supporting evidence, which was not an infrequent practice.

Mr. Leighton had made a good point regarding the use of averages when referring to patient age. Great care must be taken not to mislead by such means, and great care had been taken.

The use of SN plane and horizontal to assess mandibular features might not be customary. So long, however, as the patient was in occlusion and care taken over the postural element, results would be reliable. The mandibular plane showed too much variation from person to person and was not employed for this reason.

Mr. Parker had asked whether it would be a good idea to remould the alveolus at an early age? One had to remember that early alveolar moulding was the result of early environmental balance. This balance changed gradually to variable degrees, usually in favour of the orthodontist, as the patient aged. Mr. Fletcher said that he would have thought that orthodontic interference would be more likely to produce results that were stable the more the environment had changed to favour treatment. This meant late treatment rather than early.

Replying to Mr. Russell's point about root angulation and the use of a template, Mr. Fletcher said that he had been getting at where the developing tooth rotated and pivoted. It would not matter whether later the root was dilacerated; it would give the same pivotal point.

In replying to Mr. Steel, Mr. Fletcher said that perhaps his methods in tracing the original alveolar outline could be considered to some extent arbitrary. The method, however, was a standard one. The production of alveolar outline in the average diagrams had to be based on known points of reference, i.e., horizontal and vertical dimensions and the long-axis angulations.

Mr. Pringle had mentioned the effect of the tongue size. Mr. Fletcher said that this was an undoubted factor in alveolar moulding, but as far as the lower alveolus was concerned there were the additional factors of tongue relationship to mandible at the time of attachment formation. The variable relationships once formed would persist with attendant effect upon the lower alveolus. In the case of the upper alveolus, in addition to tongue size, there would be the matters of facial height and the direction of mandibular descent during growth.

Mr. Fletcher replied to Mr. Menezes by saying that he had not been personally responsible for the radiography. He understood the techniques employed had not differed substantially for any case. He had noted that, in the case of the very young, the maternal arm had been preferred as support to the head in place of the cephalostat.

A PRACTICAL AND CLINICAL ASSESSMENT OF TREATMENT BY ELASTIC ACTIVATOR

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HISTORY

SHORTLY after the beginning of this century, an appliance consisting of upper and lower plates united into one unit partly covering the occlusal surfaces of the teeth, the monobloc, was introduced by Robin (1902).

No great enthusiasm was aroused until Andresen (1936) described his activator, further harnessing the forces of the orofacial musculature and guiding the eruption of the teeth themselves. This activator, or functional appliance, has been widely used for both active treatment and passive retention, most notable among the pioneers being Haupl, Grossmann, and Clarkson (1952). Stockfisch (1956) reviews the literature and describes modifications by Petrik (the divided labial bow, palatal screw, and loop springs for treatment of crossbite), Muzi (the further reduced activator with free moving mandible), Beauregardt (the double-plate activator incorporating tongue depressor), Planus (the activator with double plates guided on planes with lingual locking extension), Tegtmeier (the activator with flexible rubber propulsor), Schwartz (the activator with double plates and lateral extensions and the activator with double anterior bite plates), Bimler (the elastic activator), Stockfisch (the double plate activator united elastically in the anterior oral cavity and the Kinetor), Grossmann (the reverse monobloc for Class III intermaxillary traction), and Merle-Beral (the double plate activator with sliding flange and slot).

A B

Fig. 1.—A, Anteroposterior view of activator, showing tongue-thrust guard; B, Activator viewed from above, showing palatal 'Z' spring to $\overline{5|}$.

DESCRIPTION

(*Fig.* 1)

The appliance used in the present assessment owes its origin to variations on the themes of Bimler and Stockfisch, consisting of two upper side plates joined across the midline by a coffin spring and two lower side plates joined across the midline by a lingual bow, the upper and lower components being united by wires leaving the lower lingual areas occlusally between the lower premolars and then forming distally running buccal loops which, on their return, enter the palatal areas occlusally between the upper premolars or their deciduous predecessors.

MODIFICATIONS

(*Fig.* 2)

Auxiliary springs on the palatal or lingual surfaces can be incorporated for individual tooth movement. In cases of bimaxillary

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protrusion with favourable soft-tissue patterns, where interdental spacing or planned extractions permit, both upper and lower labial bows may be inserted to maintain light physiological forces while relieving the contact on the palatal and lingual surfaces, thus improving the incisor

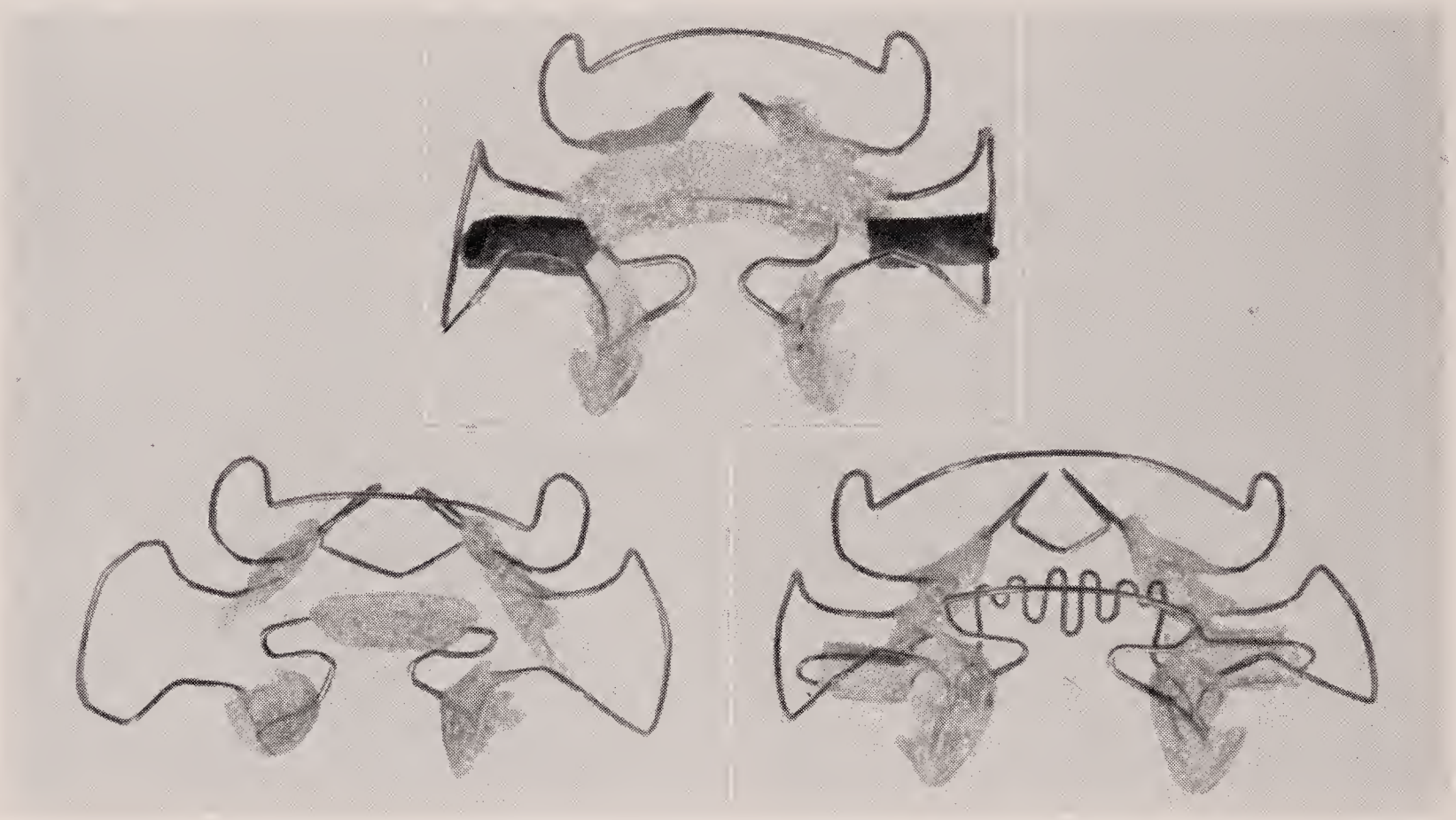


Fig. 2.—Activators showing: *Lower left* before stops were added capping $\overline{21|12}$; *Top centre*, with original rubber stops and capping $\overline{21|12}$; *Lower right*, with polythene stops and tongue-thrust guard.

to dental base angulation within the stable limits of the muscle balance for the particular case.

Again, in anterior open bite conditions, especially where these are due to abnormal tongue-thrusting pressures, a specially constructed tongue-thrust guard is included on the lower lingual aspect to intercept these thrusts and permit the circum-oral musculature to exercise greater extra-oral pressure, thus allowing the forces of eruption to achieve a normal upper to lower incisor relationship.

The main reason for the past unpopularity of this type of appliance in this country is its widely reported frailty, especially at the curvature of the buccal loop which takes most of the recurrent stresses of the muscle forces. This was encountered at the commencement of this assessment and gave origin to the most important modification. This consisted of a passive loop from the palatal plate bilaterally, just projecting buccally at right-angles to the anteroposterior buccal freeway or interocclusal space and positioned centrally in the vertical dimension: over these loops were fitted short lengths of rubber tubing, but this proved too vulnerable and has now been altered to very tough polythene tubing. A gauge is chosen smaller in diameter than would normally fit these stops, and this is fitted easily when previously softened in boiling water and allowed to cool in situ.

When depression of the lower incisors is desirable previous to an attempted establishment of the normal upper to lower incisal relationship, capping of the lower ineisors can be included on the lower half of the appliance, although it should be understood that it is not always orthodontically desirable or physiologically possible to achieve and maintain the so-called 'ideal' incisal relationship.

CONSTRUCTION

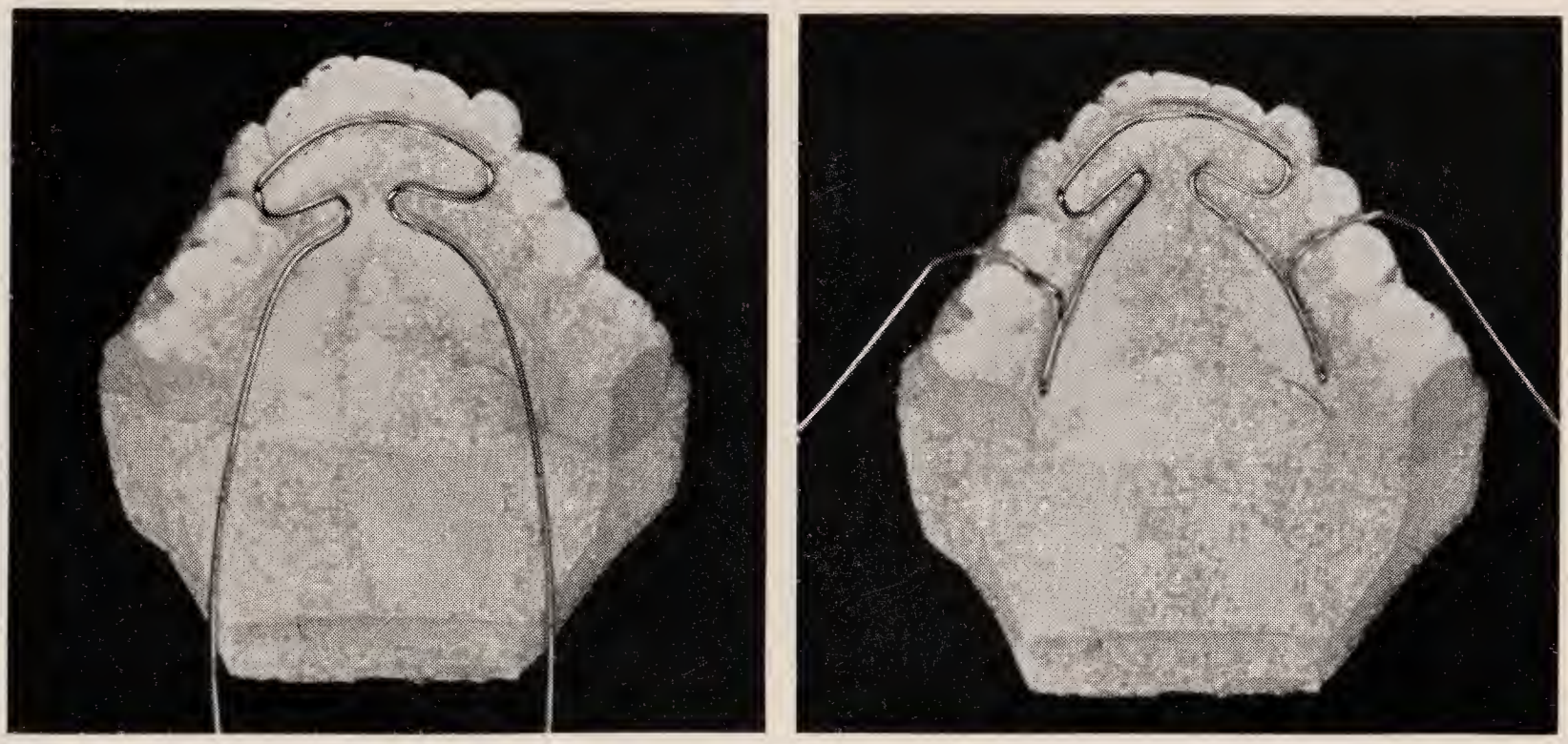
(*Fig.* 3)

In the surgery, the usual preparation of impressions, models, and bite block as is described for the monobloc is followed except that now a more anteriorly positioned mandible can be tolerated. In some cases this can be

taken as far as the incisal edge-to-edge position in view of the elastic nature of the appliance, although an intermediate stage is advisable in the more severe types of Class II malocclusion, to prevent the activating musculature from over-exertion and fatigue. The resting position should be opened by between 2·0 and 4·0 mm., and the greatest care must be taken to retain or correct the midline position, as necessary.

In the laboratory, the models are mounted on an articulator with the bite block: a length of 0·9-mm. stainless-steel wire about 12 in. long is taken, and wire bending is started in the lower arch, beginning with the centre. The lingual bow is adapted to the lingual surface of the lower anterior teeth, bending the horizontal U loops in the $\overline{3|3}$ areas and bending under and back in line with the mesial edges of $\overline{2|2}$. These arms are continued back to a line level with the centre of $\overline{6|6}$, and then doubled back on themselves and passed out buccally between $\overline{54|45}$: these wires are now bent downwards and backwards just below the gingival margin, care being taken not to touch the tissue. The upward bends are commenced in line with the centre of $\overline{6|6}$ and curved upwards and backwards as far as the distal edges of $\overline{6|6}$; these are then passed forwards again and fitted into the palatal surfaces between the $\overline{54|45}$ (*Fig.* 4).

The labial bow and a palatal coffin spring are constructed separately with 0·9-mm. stainless-steel wire (*Fig.* 5 A), while 0·8-mm. wire is used for the passive interocclusal loops. Wax is adapted to the models, the warmed wires are pushed into position, and the activator is



A B

Fig. 3.—Wire bending of lower arch. A, Stage 1; B, Stage 2.

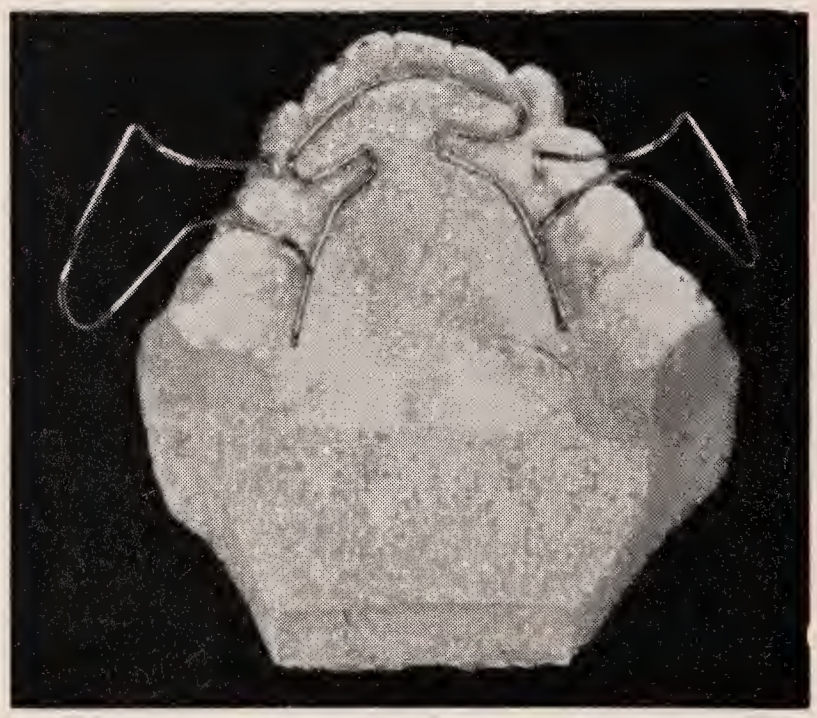
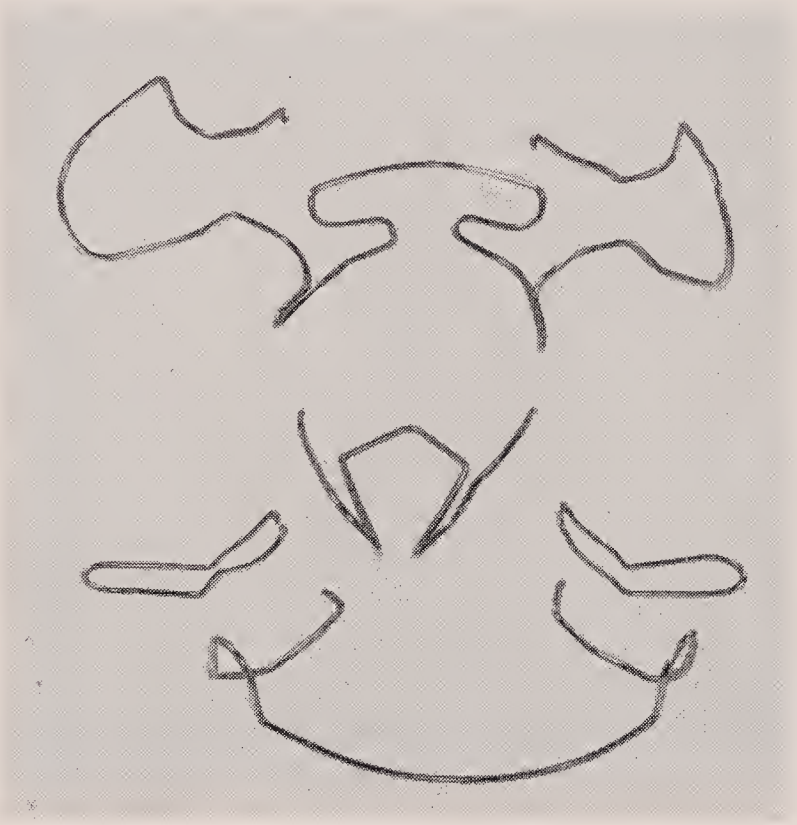


Fig. 4.—Main activator wire completed.

waxed up. Flasking is achieved by filling the central cavity of the appliance with tissue paper and pushing the appliance into the plaster with the labial bow towards the base of the flask (*Fig.* 5 B). When the base is set, the top is cast, allowed to set, and tapped open; then the wax is boiled out and the flask packed and processed. The processed activator is trimmed, polished, and checked on the models.

MODE OF ACTION

The elastic activator obtains its intermaxillary forces (controllable within acceptable physiological limits without pathological disturbances of the dental or periodontal tissues) from the muscles of mastication and deglutition. The muscles are brought into action during the normal mechanism of 'idle swallowing', which is initiated every few minutes throughout life, controlling the free oral content of saliva, the presence of the activator in the oral cavity tending to stimulate an increased flow of saliva, adding to the normal content already present for disposal. Further muscular reaction is created by the activator in a position of artificially increased interocclusal or freeway space, causing the muscles to repeatedly attempt to return to the physiological rest position (*Fig.* 6).



A

B

Fig. 5.—A, *Top*, completed activator wire; *Bottom*, palatal coffin spring, freeway stops, and labial bow. B, Flasking.

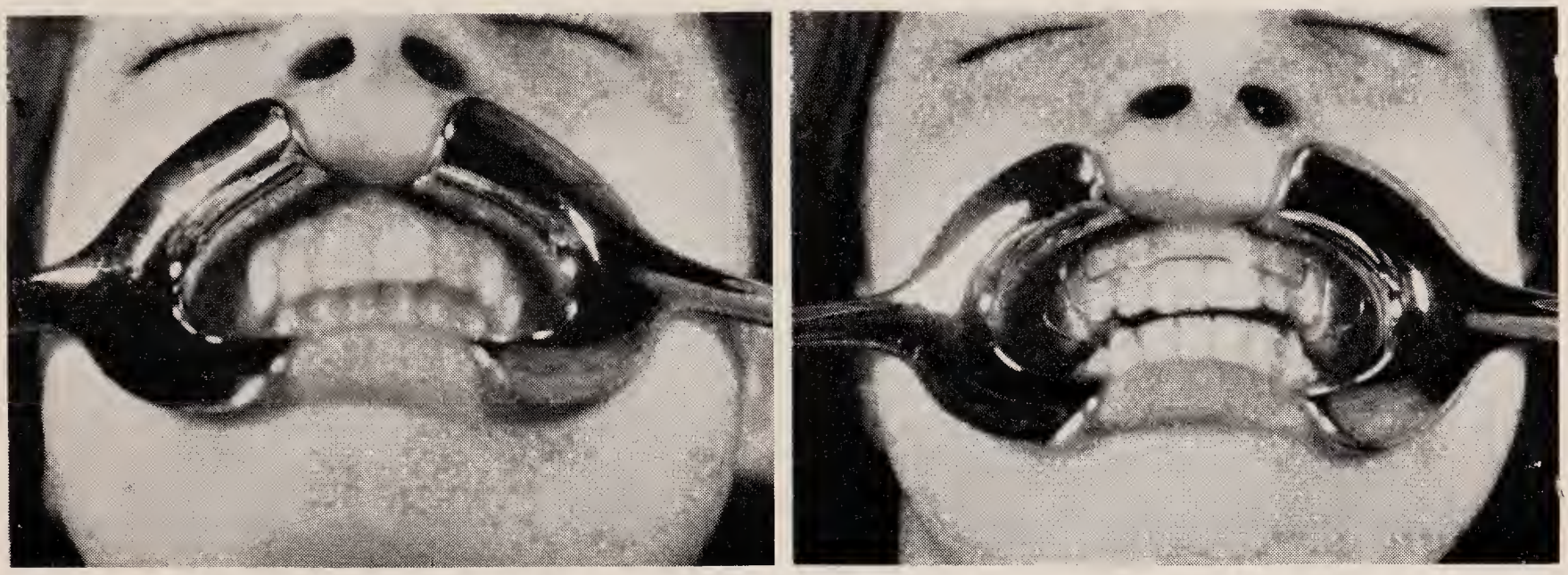
It is interesting to note that it has been stated by Dickson (1959) that during treatment with the Andresen appliance this neuromuscular mechanism of swallowing may be modified. Stockfisch (1956) describes the movements and pressures of the mandible and the tongue being employed and transmitted, with the aid of the appliance, to the teeth, the maxilla, and the mandible.

The mandible, being guided downwards and forwards from its physiological rest position, retracts upwards and backwards during the 'idle swallow' and any additional contractions that are initiated by the presence of the activator. This upward and backward thrust is conveyed through the elastic activator to the upper teeth, which initiates a reciprocal action downwards and forwards to the lower teeth.

The more continuously the appliance is worn, the more constantly are these forces at work, and the tooth movement through the alveolar bone is kept fluid. These repeated light pressures which are constantly being initiated are the only active forces required to move the teeth.

Expansion of the upper or lower arches, either anteriorly or posteriorly, or both, can be

obtained within the accepted restrictions laid down by the soft-tissue balance and the apical base relationship. Many critics regard this type of expansion as haphazard and uncontrolled, but after some practical expericnce one, or both, of the buccal segments can be activated; the actual opening distance is measured by marking the upper and lower plates anteriorly and posteriorly and measuring these distances across the midline with callipers.



A B

Fig. 6.—A, Patient in occlusion, showing Class II, division 1 overjet. B, Activator in situ, showing new postural position, corrected midline, and the opening of the freeway space.

ADVANTAGES

The chief advantages of the elastic activator over the more rigid monobloc or activator are:—

1. The much greater tolerance and acceptance by the patient, who is not forced to accept the new anteroposterior relationship but can posture against it, thereby unconsciously bringing into play the very forces of activation.

2. The freely open anterior aspect of the appliance, making mouth breathing possible, especially suitable in cases of asthma, mild upper respiratory infections, and the common cold.

3. The apparent non-confincment of thc tongue, giving a sense of virtual freedom in the oral cavity, enabling thc appliance to be worn during the daytime and evening as well as during the night, and almost normal speech can be very quickly re-established.

4. The ease with which simple adjustments can be carried out, and the important factor of the fairly infrequent appointments required, after the initial stages, making it suitable for boarding-school and similar difficult cases.

5. The large variety of malocclusions which will respond to treatment by this appliance, and the relatively short active treatment time required.

DISADVANTAGES

1. More laboratory time is required for its construction than for the monobloc type of appliance, flasking is difficult, and great care must be taken to leave no undercuts: deflasking and polishing are also liable to be difficult.

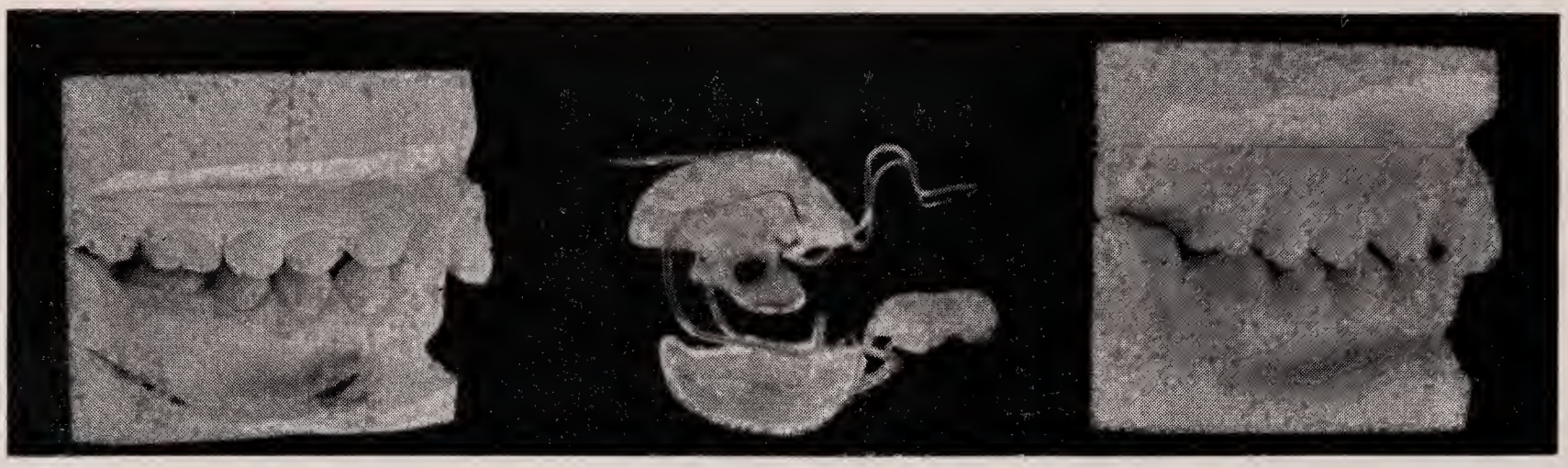
2. The greater liability to fractures and distortions, although these have been markedly reduced since the addition of the passive interocclusal loops bearing the polythene tubing.

3. The more problematic types of repair required where processing are not feasible and these have to be undertaken, quite effectively, with a rapid-curing acrylic resin. Repairs on the buccal wires are carried out by slipping a piece of tubing over them and pinching it together.

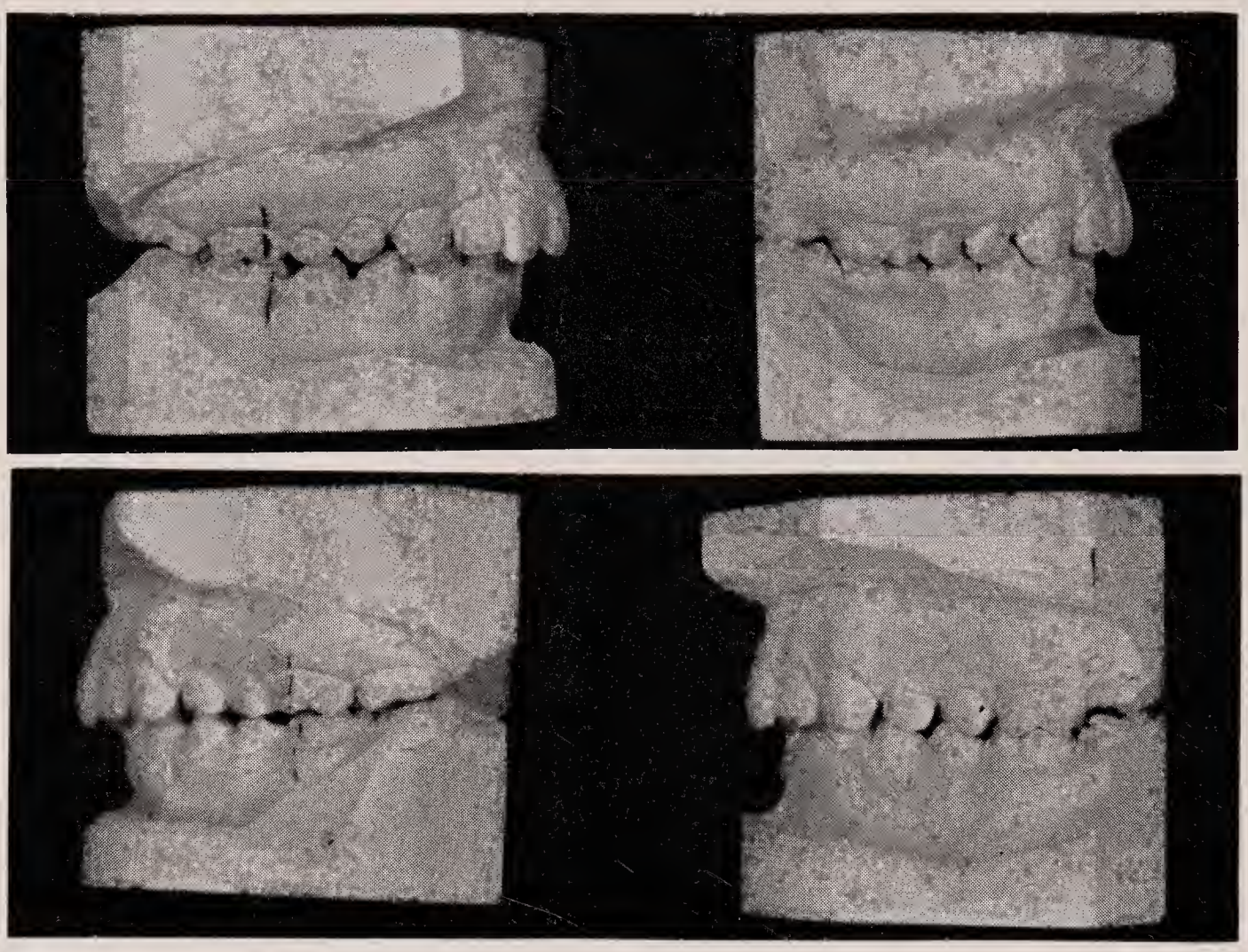
CONCLUSIONS

The present assessment was undertaken on a random 80 cases treated by the appliance, although the number now completed and under treatment is nearly 200.

All the skeletal measures were assessed clinically in the surgery (a series of these were



A



B

Fig. 7.—A, Mild Angle's Class II, division 1 before and after treatment with appliance. B, Mild Angle's Class II, division 1. *Upper and lower left*, before treatment; *Upper and lower right*, after treatment, showing reduction of overjet and more stable interdigitation of buccal segments.

Fig. 8.—Severe Class II, division 1, showing reduction of overjet and closure of interdental spacing. *Right*, before, and *left*, after treatment with appliance. (Note: correction of $\frac{6}{6}\Big|$ occlusion.)

checked by the lateral skull tracings and the variation was mainly within 1° to 3°, the main exception being those cases having gross discrepancies of soft-tissue covering and tooth, root, or bone malformations).

responses were noted in all the Angle's Class II, division 2 cases undertaken.

Those cases that best responded to treatment had a range of normal-to-mildly-proclinated lower incisors to mandibular-plane

Fig. 9.—Class II, division 1 with upper incisal spacing. *Left*, before treatment; *Right*, after 8 months' treatment without extractions.

A

B

Fig. 10.—A, Patient showing grossly incompetent lips, but lower lip just over $\overline{1|1}$ tips. B, Anterior open bite due to tongue-thrust: before and after treatment.

The best response to treatment was noted in the Skeletal I and the mild to fairly severe Skeletal II cases (*Fig.* 7); beyond this, the very severe Skeletal II cases had to be later treated by extractions and retraction where possible (*Figs.* 8, 9). It showed most notably in the type of malocclusion most frequently seen in this country, namely the Angle's Class II, division 1, but very remarkable and rapid

angulation, and a normal-to-fairly-severely proclinated upper incisor to Frankfurt plane angulation. Their Frankfurt plane to mandibular-plane angles varied between 27°

and 40° measured extra-orally over the soft tissues. The upper central incisor sizes varied from 7 to 10 mm., and the typical or 'teeth together' swallow was in evidence, although quite a reasonable number of atypical or 'teeth apart' swallows responded very well. Such cases that were assessed with an endogenous tongue-thrust (Ballard, 1961) showed little or no improvement during treatment.

The competence of the lips did not seem to show any special significance although, as may be expected, a fair content of Class II cases showed a slightly larger number of incompetent lips which responded equally well to treatment (*Fig.* 10 A). A fairly strong mentalis contraction on swallowing appeared in those cases favourable to response.

Among the various habits, very good results (*Fig.* 10 B) were recorded in cases of thumb- or finger-sucking, while mild to fairly strong degrees of tongue-thrust responded well, and the tongue appeared most frequently in the mid-to-high oral cavity position.

Acknowledgements.—I would like to record my thanks to Miss M. Pugh, of the Photographic Department, Queen Mary's Hospital for Children, Carshalton, Surrey; to Sister J. M. Benns, of the Dental Department; and to Mr. R. E. Box, for their valuable assistance; and to Mrs. E. Farmer, for her secretarial help.

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DISCUSSION

Mr. Gibson asked Mr. Westbrook to elaborate on his selection of the cases. He seemed to have rather a large number with very severe crowding in the upper and lower incisor region, and that did not seem to be a type of case which responded very well to conventional Andresen appliances.

Mr. H. E. Wilson said that Mr. Westbrook had mentioned that the 80 cases were selected at random. Was it to be assumed that they were all completely successfully treated?

Why had Mr. Westbrook selected 2 mm. for the opening? Thirdly, Mr. Westbrook had mentioned the endogenous type of swallowing behaviour: how did he diagnose this?

Mr. W. B. Senior asked if Mr. Westbrook required his patients to wear their appliances during the night? He thought that Dr. Bimler insisted that his patients wore them for eating as well. Did Mr. Westbrook also insist on this?

Mr. N. M. Poulter asked what was the usual length of time Mr. Westbrook anticipated the patient wearing the appliance before some appreciable change was seen.

Mr. Westbrook, in reply, said that he would like many more of the cases to be out of active treatment for one, two, or three years and then be able to show much more detailed slides of actual models from the beginning and well out of retention. This he knew was very necessary. Unfortunately, at the moment, a year, or eighteen months possibly, was the most he had had them out of retention.

Once he had stabilized the upper arch, possibly by extraction of second molars, there was no active retention appliance.

With regard to selection of the cases, this was just as they arrived. It was the first 80 cases he had completed. He had tipped them out in that order and every type of case was treated, except Class III.

They were not all successfully treated. He had been very interested in the Andresen type of appliance and used a lot of them. He had many throw-outs because patients would not wear them, and when he changed to the activators he had far more successful wearing of them. One or two did not continue. But they were not all successful; some just disappeared, as patients did under treatment.

He had used the 2–4 mm. possibly because all the textbooks gave this.

With regard to the endogenous tongue-thrust, this was difficult to assess.

The most dramatic changes during treatment were those where he waited until the upper second molars had erupted, then extracted those and put the activator in; within six weeks big changes were occurring. Usually, he saw a case after six weeks just to let the patient get thoroughly used to it and put down everything on paper that he did not like. He then saw him once in three months, but in the first six weeks when he had taken out the upper second molars, the third molars being present and in a useful position, then he noticed the most rapid response.

REPORTS OF MEETINGS

ORDINARY MEETING, 14 January

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 14 January, 1963.

The President, Mr. A. G. Taylor, was in the Chair. The Minutes of the last meeting were read by the Secretary and agreed. Apologies for absence were received from Dr. W. Russell Logan, Mr. J. F. Pilbeam, Mr. D. A. Dixon, Mr. H. L. Lester, and Mr. A. G. T. Allcorn.

The following candidates for membership were elected:—

Mr. M. H. Fanner, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), 'Wynott', Abbotts Way, Southampton, Hants.

Mr. G. M. Bransby-Zachary, L.D.S. R.C.S. (Eng.), D.Orth. R.C.S. (Eng.), 103, Brighton Road, Sutton, Surrey.

Mr. N. L. Hill, L.D.S. (U. Leeds), 69, Northampton Road, Addiscombe, Croydon, Surrey.

Mr. E. B. Williams, B.D.S., L.D.S. (Manc.), Dalkeith, Ringwood, Hants.

The President welcomed visitors and then delivered his Presidential Address on:—

'The Future of the Society'

EXTRAORDINARY GENERAL MEETING, 11 February

An Extraordinary General Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 11 February, 1963. In the absence of the President, Dr. W. J. Tulley was in the Chair.

The meeting considered an amendment to the Bye-Laws submitted by the Council:—

1. Addition of a further section to the Bye-Laws after the present Section 8:—

'**Life Members**: Any member of at least thirty-five years standing may be nominated for Life Membership by four properly qualified members. Such nominations shall be approved by the Council before submission to the Society for election. Their election shall be conducted in the same manner as that of ordinary members. They shall not be required to pay any contribution, and shall enjoy all the privileges of other members, except those of holding office or taking part in any question relating to the management of the Society's affairs; or voting for the admission of Members or other Life Members.'

2. Amendment of Section 25 of the Bye-Laws to the following:—

'No sum of money exceeding Twenty-five pounds shall be paid by the Treasurer, on account of the Society, unless such payment be previously sanctioned by the Council: and all cheques for Fifty pounds and over shall be countersigned by the Secretary. At each Council Meeting the Treasurer shall report all amounts over Five pounds that have been paid since the previous Council Meeting.'

In the absence of any discussion, the amendment was approved unanimously.

ORDINARY MEETING, 11 February

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 11 February, 1963, following the Extraordinary General Meeting. In the absence of the President, Dr. W. J. Tulley took the Chair.

The Minutes of the previous meeting were read and approved.

Apologies for absence were received from the President, Professor C. F. Ballard, Dr. W. Russell Logan, Dr. J. R. E. Mills, and Mr. D. A. Dixon.

Mr. M. H. Fanner and Mr. E. B. Williams were introduced to the Chairman and signed the Obligation Book.

The following candidates for membership were elected:—

Mr. M. Berman, L.D.S. R.C.S. (Eng.), 57, Portland Place, London, W.1.

Mrs. H. C. Pearce, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), 193, Nelson Road, Gillingham, Kent.

Miss M. M. Topham, B.D.S. (Lond.), L.D.S., D.Orth. R.C.S. (Eng.), 101, Clitherow Avenue, Hanwell, London, W.7.

The PRESIDENT then introduced Mr. J. C. Ritchie who read his short communication:—

'The Hereditary Tendency in Two Cases of Partial Anodontia'

This was followed by two short papers: One by Mrs. E. M. Carvalho entitled:—

'A Supplemental Molar'

and the other by Mr. B. H. Miller on:—

'The Influence of Congenitally Missing Teeth on the Eruption of the Upper Canine'

ORDINARY MEETING, 11 March

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 11 March, 1963, at 7.30 p.m., with the President, Mr. A. G. Taylor, in the Chair.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the Extraordinary General Meeting held on 11 February, 1963, and of the Ordinary Meeting held on 11 February, 1963. The Minutes were confirmed and signed.

The CHAIRMAN thanked Dr. W. J. Tulley for taking the Chair at the Extraordinary General Meeting.

An apology for absence had been received from Mr. J. Beresford.

The following members, whose election had been confirmed at a previous meeting, were introduced to the President: Miss E. S. Davidson, Mr. A. J. Keniry, Miss M. M. Topham, Miss M. Campbell Wilson, Mr. A. Frazer, Mr. M. Berman, and Lt.-Col. E. S. Foster.

The following candidates for membership were elected:—

Mr. R. J. Belcher, L.D.S. R.C.S. (Eng.), 'St. Michael's', 111, Bell Street, Reigate, Surrey.

Mr. W. J. Ballantyne Houston, B.D.S. (Edin.), 15, Park Avenue, Edinburgh 15, Scotland.

Mr. J. G. McCracken, B.D.S. (L'pool), D.Orth. R.C.S.(Eng.), 33, High Bebington Road, Bebington, Wirral, Cheshire.

Mrs. E. M. Lynch, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), D.Orth., 146, Holland Park Avenue, London, W.11.

Mr. L. A. Usiskin, L.D.S. R.C.S. (Eng.), B.D.S. (Lond.), 26, Kingsley Way, Finchley, London, N.2.

Dr. J. R. E. Mills then read a short communication entitled:—

'Orthodontic Wires'

drawing members' attention to the British Standard specification No. 3507 : 1962 on 'Orthodontic Wire and Tape and Dental Ligature Wire made of Stainless Steel'.

The PRESIDENT then introduced Mr. C. C. Knowles who read his paper entitled:—

'The Influence of Cranial Base Structure on the Orientation of the Middle Third of the Face'

SCIENTIFIC MEETING, 16 May

The first SCIENTIFIC MEETING of the Society was held at the West Norwich Hospital on Thursday, 16 May, 1963, before which lunch was provided for members by the Hospital Management Committee. At the invitation of the President, Professor C. F. Ballard took the Chair and Research Reports were given according to the following programme:—

'A Comparison of Maxillary Arch Width in Crowded and Uncrowded Dentitions at 5 Years of Age', by C. P. Adams.

'An Analysis of Selected Hereditary Traits in a Family with Twelve Children', by W.A.B. Brown.

'The Incidence of Enamel Hypoplasia in Children with Cleft Palate', by D. A. Dixon.

'Research into the Treatment of Cleft Lip and Palate Conditions', by A. G. Huddart.

'Intra-oral Muscle-pressure Measurement', by J. K. Luffingham.

'The Aetiology of Malocclusion: a Further Report on a Comparative Survey of Bristol Undergraduates and Schoolchildren', by J. C. Stephenson.

Each report was followed by a discussion.

COUNTRY MEETING, 17 and 18 May

The COUNTRY MEETING of the Society was held in the Flixton Rooms, Norwich, on Friday and Saturday, 17 and 18 May, 1963.

The PRESIDENT (Mr. A. G. Taylor) welcomed delegates to the Country Meeting.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the previous meeting, which were confirmed and signed as a correct record.

Apologies for absence were received from Dr. Russell Logan, Professor Ballard, Mr. Allcorn, and Mr. Birnie.

The following members, elected at previous meetings, were then introduced to the President: Messrs. R. J. Belcher, N. L. Hill, and J. G. McCracken.

The PRESIDENT welcomed visitors to the Country Meeting and asked that they consider themselves members for the duration of the Meeting.

Papers and demonstrations were then delivered according to the following programme:

Programme

Friday, 17 *May*

9.30 a.m. Short Paper: Mr. G. A. James: '*Cephalometric Analysis of* 100 *Angle Class II, Division* 1 *Malocclusions with Special Reference to the Cranial Base*'.

10.15 a.m. Short Communication: Dr. L. M. Clinch: '*Early Treatment of a Prenormal Mandible*'.

11.00 a.m. Coffee.

11.15 a.m. Chairman: Mr. J. F. Pilbeam.

Paper: Dr. G. W. Moss: '*The Begg Philosophy and Treatment*'.

12.30 p.m. Luncheon.

2.00 p.m. Demonstrations: Mr. E. S. Broadway: '*The Unusual*'. Mr. D. G. Huggins: '*Functional Retention*'. Mr. C. P. Adams: '*The Illustration of Orthodontic Material*'. Mr. D. T. Bennett: '*Fractured Incisors*'. Mr. J. G. McCracken: '*Rapid Maxillary Expansion*'. Mr. A. Westbrook: '*Abnormalities in a Number of Teeth*'. Mrs. M. E. Richardson: '*The Extraction of Lower Incisors in Orthodontic Treatment*'. Mr. B. C. Leighton: '*Cases illustrating Spontaneous Changes in the Dental Arches during the First Nine Years of Life*'.

4.00 p.m. Tea.

7.30 p.m. for 8.15 p.m. Formal Dinner (Flixton Rooms).

Saturday, 18 *May*

9.30 a.m. Chairman: Mr. S. G. McCallin.

Symposium: Mr. W. Nicol and Mr. H. E. Wilson: '*Angle's Class II, Division* 2 *Malocclusion*'.

11.00 a.m. Coffee.

11.30 a.m. Chairman: Professor D. P. Walther.

Paper: Mr. P. T. Heffer and Mr. B. B. J. Lovius: '*An Orthodontic Survey of the Islanders of Tristan da Cunha*'.

12.30 p.m. Luncheon.

2.00 p.m.: Chairman: Dr. L. M. Clinch.

Short Communication: Mr. T. D. Foster: '*Self-treatment of Malocclusion*'.

2.30 p.m. Short Paper: Dr. G. R. Seward: '*The Localization of Unerupted Maxillary Teeth*'.

3.30 p.m. Film: Dr. W. J. Tulley: '*A Visit to Hawaii and the United States*'.

4.00 p.m. Tea.

ORDINARY MEETING, 14 October

An ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 14 October, 1963, at 7.30 p.m., with the President, Mr. A. G. Taylor, in the Chair.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the Sixth Country Meeting held on Friday and Saturday, 17 and 18 May, 1963, at Norwich. The Minutes were confirmed and signed.

An apology for absence was received from Dr. W. Russell Logan.

The following candidates for membership were elected:—

Mr. M. J. Munday, B.D.S. (Adelaide), 161, Turner's Hill, Cheshunt, Herts.

Mr. H. M. J. Y. Ovington, L.D.S. R.C.S., S.H.A.P.E. Dental Unit, Camp Voluceau, Paris.

Mr. J. Abensur, D.D.S., D.D.O. (Glas.), Jiron Moquega 157 of 310 Lima, Peru, South America. (Corresponding Membership.)

Mr. L. Oosthuizen, B.D.S. (Rand), D.Orth. R.C.S., 631, Robert Koch Medical Building, Pretoria Street, Pretoria. (Corresponding Membership.)

The PRESIDENT announced that the Council of the Society had decided to award the Chapman Prize to Mr. C. D. Parker for his essay entitled:—

'*A Comparative Study of Intermaxillary Spaces with Treated and Untreated Occlusions*'

Mr. A. Westbrook then read a short paper entitled:—

'*A Practical and Clinical Assessment of Treatment by Elastic Activator*'

This was followed by two short papers, one by Mr. C. D. Parker on:—

'*The Bodily Retraction of Upper Incisor Teeth using a Modified Begg Arch*'

and one by Mr. B. C. Leighton entitled:—

'*A Modification of the Watkin Pin and Tube Appliance*'

ORDINARY MEETING, 11 November

An ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 11 November, 1963, with Mr. A. G. Taylor, the President, in the Chair.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the Meeting held on Monday, 14 October, 1963, and these were signed as a correct record.

An apology for absence was received from Dr. W. Russell Logan.

The following candidates for membership were elected:—

Mr. H. I. Cohen, L.D.S. (U. Durh.), 175, Coulsdon Road, Caterham, Surrey.

Mr. J. F. Gravely, L.D.S. (Manc.), 35, Longley Road, Almondbury, Huddersfield, Yorks.

Mr. T. J. Freer, B.D.Sc., D.Orth. R.C.S., 7/9 King Street, Hinckley, Leics.

B. D. Bowden, 145, Collins Street, Melbourne, Australia. (Corresponding Membership.)

Mr. G. Manara, 50, Rudolph Street, Sliema, Malta. (Corresponding Membership.)

Mr. R. Gonzalez, Pilar 2, Santa Cruz, Tenerife, Canary Islands. (Corresponding Membership.)

The PRESIDENT welcomed visitors to the meeting and asked them to consider themselves as members for the evening.

The President, after describing the originator of the Northcroft Memorial Lecture, introduced Dr. Alice M. Copping, Reader in Nutrition at the University of London at Queen Elizabeth College, Campden Hill, who gave her Lecture entitled:

'*Nutrition and Growth*'

A vote of thanks to the lecturer by Dr. W. J. Tulley was carried with acclamation.

ANNUAL GENERAL MEETING, 9 December

The ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 9 December, 1963, at 7 p.m.

Minutes.—The SECRETARY (Mr. B. C. LEIGHTON) read the Minutes of the Annual General Meeting held on Monday, 10 December, 1962. The Minutes were signed by the President as a correct record.

Apologies for absence had been received from Dr. W. Russell Logan, Mr. E. S. Broadway, and Mr. D. A. Dixon.

Election of Officers and Councillors.—Nominations put forward by the Council had been circulated with the Agenda, and no other nominations had been received. Therefore the following Officers and Councillors were declared elected:—

President:	Dr. W. J. Tulley
Immediate Past President:	Mr. A. G. Taylor
President Elect:	Mr. A. J. Walpole Day
Senior Vice-President:	Professor C. F. Ballard
Vice-President:	Mr. J. D. Hooper
Councillors:	Mr. C. P. Briggs
	Mr. E. S. Broadway
	Mr. M. A. Burley
	Mr. D. A. Dixon
	Mr. J. D. McEwen
Treasurer:	Mr. J. S. Rose
Secretary:	Mr. A. C. Campbell
Editor:	Dr. J. R. E. Mills
Curator:	Mr. B. C. Leighton
Librarian:	Mr. D. I. Smith

Election of Auditors.—On a motion proposed by Mr. Breakspear, Messrs. J. F. Pilbeam and P. H. Burke were elected auditors for the ensuing year.

Report of the Treasurer.—The TREASURER (Mr. J. S. ROSE) reported that this year's accounts showed an excess of income over expenditure of £503 15s. 9d. The actual expenditure had remained more or less the same, in spite of the increase in the cost of secretarial assistance, and of the Chapman Prize expenses occurring for the first time. These increases were balanced by the reduction in cost of the TRANSACTIONS. Subscriptions showed an increase, but part of their additional income was accounted for by the sale of TRANSACTIONS, for which he must once again express appreciation to the Honorary Librarian.

Mr. J. S. Rose moved the reception of the Treasurer's Report.

The President seconded the motion, and asked if any one wished to ask questions of the Treasurer.

There were no questions or comments.

The President moved that the Treasurer's Report be adopted.

The report was *adopted*.

Report of the Secretary.—The Secretary (Mr. B. C. Leighton) said it was once again his pleasant duty to report an increase in the membership of the Society. A loss of 14 members had been offset by the addition of 23 new members to bring the total to 528. Perhaps a better yardstick of the increasing interest in orthodontics was the attendance at meetings, which averaged 96 over the year. This was in spite of the effect of very severe weather on the January and February meetings.

This year had been a particularly eventful one in which the climax had come with the Country Meeting in Norwich. As an experiment, an innovation had been introduced before the Country Meeting, in the form of a session devoted to Research Reports, the success of which had been largely due to the efforts of Mr. P. H. Burke and Mr. E. S. Broadway. The Society had been fortunate in being offered hospitality by the East Anglian Regional Hospital Board, who had provided not only facilities for presenting the reports, but also refreshment of a very high standard. Accommodation for this session was limited, however, and it had been arranged that application for this should be made in advance.

Considerable variety had been achieved at the Country Meeting in the selection of papers, which had ranged from 'Cephalometric Analysis of Class II, Division 1' to 'Life in Hawaii'. To some the latter might prove to have been the most memorable event of the year. Others, however, had reason to recall it as the year in which Life Membership was introduced. The Council had now appointed a sub-committee to review the advantage which might be gained by the moving of the start of the Society year from January to the beginning of the winter session. This sub-committee had also been charged with the task of making recommendations concerning the time of each meeting.

It was now five years, Mr. Leighton said, since he had accepted the care of the affairs of the Society as its Secretary. Since that time further development had brought the Society very nearly to a crossroads in its evolution. Whereas the increase of attendance was most gratifying, at the same time it created a more formal atmosphere, which might in time discourage free discussion. A solution to this might be found in the encouragement of regional gatherings, especially in the depth of winter. He thought they would soon have to face the need for a permanent secretariat to serve a more sophisticated form of Society, which was likely to come under increasing pressure to involve itself more deeply in all aspects of orthodontics.

In closing his report, Mr. Leighton said he would like to pay tribute to Mr. H. L. Leech, who had handed him the reins of office in such good order, and to express a hope that they were in as good shape now as he in turn passed them into the capable hands of Mr. Alan Campbell.

Mr. Leighton moved the reception of the Secretary's Report and Mr. Smith seconded the motion.

The President said the report was open for discussion. This was Mr. Leighton's last report as Secretary: he had put a number of equivocal suggestions into it. One of the things on which they would like the views of members was the hour of the meeting. It had been at 7.30 p.m. since the war: was that considered a good time?

After a lively discussion, in which a number of members took part, Mr. R. W. Willcocks proposed, and Mr. J. D. Hooper seconded, a motion that the Secretary should circulate with the next Agenda a note to all members asking them what would be the most convenient time of the month for the meeting to be held.

The motion was carried unanimously.

There being no other comments on the Secretary's Report, the President moved its adoption.

The Report was *adopted*.

Report of the Editor.—The EDITOR (Dr. J. R. E. MILLS) reported that the Society's TRANSACTIONS had continued to be published in the *Dental Practitioner*, as well as in bound form. Good relations had been maintained with the Society's publishers, Messrs. John Wright & Sons Ltd., whose production had been of the consistently high standard which they had come to expect.

The Editorial Committee was always pleased to receive papers from members for delivery at the Society's meetings. Dr. Mills would draw the attention of intending contributors both to the Society's 'Notes to Readers' and to those appearing in the *Dental Practitioner*, both of which should be consulted early in the preparation of papers. Finally, Dr. Mills said, he, as Editor, was always willing to give advice at an early stage in the preparation of papers, particularly on the presentation of illustrations.

Dr. MILLS moved the reception of the Editor's Report and Mr. J. S. BERESFORD seconded the motion.

There were no comments, and the PRESIDENT moved that the Editor's Report be adopted.

The Report was *adopted.*

Report of the Librarian.—The LIBRARIAN (Mr. D. I. SMITH) said the Library was housed rather inadequately in the Institute of Public Health next door to Manson House. TRANSACTIONS, books, and periodicals were on loan to members. The Library also sold past and current TRANSACTIONS, and the increasing demand for these had resulted in more years' issues being out of print. He wished to thank those who had made gifts of TRANSACTIONS to the Society, and to appeal for further copies.

Mr. SMITH moved the reception of the Librarian's Report and Dr. W. J. TULLEY seconded the motion.

The PRESIDENT said, as an ex-Librarian, he would like to second everything Mr. Smith had said. Since the War this Society had become more and more widely known. In the past they had had quite a pile of old TRANSACTIONS: these had now almost disappeared because they were in demand from universities and dental schools, as well as practitioners, throughout the world. Therefore if any members had spare copies for no matter what years they would be gratefully received by the Librarian, who could make very good use of them.

There were no other comments on the Librarian's Report and the PRESIDENT moved that it be adopted.

The Report was *adopted.*

The Report of the Curator.—The CURATOR (Mr. J. S. BERESFORD) said their museum cases were housed next door in the Royal Institute of Public Health and Hygiene. The Royal Institute had now closed their own museum, but despite difficulties they continued to care for the Society's exhibits, and might even be able to provide the Society with improved accommodation in the foreseeable future.

The album of photographs of past Presidents had been displayed at the Country Meeting in Norwich. With only one exception the collection of photographs was complete, and Mr. Beresford said it was a pity no one had brought along a camera with flash apparatus tonight so that that could be retified.

He moved the reception of the Curator's Report, which was seconded.

There were no comments, and the PRESIDENT moved the adoption of the Curator's Report.

The Report was *adopted.*

Mr. BREAKSPEAR said he would not like this meeting to pass without some expression of thanks to Mr. B. C. Leighton, their retiring Honorary Secretary. Those who had had dealings with him over the past five years could speak of the efficiency and courtesy with which he had always carried out his work.

Mr. Breakspear proposed that a vote of thanks be passed now and recorded in the Society's minutes. The motion of thanks was carried by acclamation.

The SECRETARY thanked Mr. Breakspear and the members for their kind remarks.

Mr. S. G. MCCALLIN proposed a vote of thanks to all the other Officers of the Society.

The motion of thanks was carried by acclamation and the Annual General Meeting terminated.

ORDINARY MEETING, 9 December

An ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, 9 December, 1963, following the Annual General Meeting.

The PRESIDENT (Mr. A. G. TAYLOR) was in the Chair.

The Minutes of the Ordinary Meeting held on Monday, 11 November, 1963, were read by the Secretary, and were signed as a correct record.

One new member, Mr. H. I. Cohen, whose election had been confirmed, was introduced to the President.

The PRESIDENT said it was his very pleasant duty to welcome all visitors and to ask them to consider themselves Members of the Society for this evening.

The President announced that the Council proposed that Mr. H. T. A. McKeag of Rugby Road, Belfast, be elected an Honorary Member of the Society. This was the greatest honour the Society could pay anyone and he put the proposal to the meeting. On a vote by show of hands, the motion was carried unanimously and Mr. McKeag was duly elected.

The President said those who had been present at the Annual General Meeting would know this was the first occasion on which they were electing Life Members. These would enjoy almost the same privileges as Honorary Members: in fact it was an honour secondary only to that of Honorary Membership.

The three Members of the Society nominated by the Council were: Mr. B. Eady, Mr. S. B. Newton, and Mr. J. A. Hudson.

All three had served the Society very well in the past, and he put it to the meeting that they be elected the first three Life Members.

On a vote by show of hands the motion was carried unanimously.

The President declared these three gentlemen duly elected Life Members.

The President then introduced Mr. D. M. MENEZES, who read the short communication by himself and Mr. R. G. MITCHELL on:—

'*Orthodontic Treatment following Opening of a Dentigerous Cyst*'

The President then called on Mr. G. G. T. FLETCHER to present his paper on:—

'*A Cephalometric Appraisal of the Development of Malocclusion*'

Vote of Thanks to Retiring President.—Mr. K. E. PRINGLE said before concluding the evening he felt sure they would like to thank Mr. A. G. Taylor, their President for this year.

He said he had first known Mr. Taylor about 1928, when he remembered him as a senior student to himself. He had always been ready to join in any argument, and usually showed just that little bit of extra knowledge that was necessary to conclude it in his favour. Later he had been House Surgeon in the Children's Department when he (Mr. Pringle) had been an Assistant House Surgeon. So to a considerable extent, Mr. Pringle said he owed what knowledge of orthodontics he had to Mr. Taylor.

He also remembered Mr. Taylor in connexion with the first experiment in soldering stainless steel. Mr. Taylor had written to Firths and asked them to provide a flux for soldering stainless steel. Watching Mr. Taylor, Mr. Pringle said he had seen the first orthodontic soldering done by anyone, to the best of his knowledge.

When Mr. Taylor had left Guy's he had gone into the School Dental Service, because he was a man who had felt the need for public service. Since then, he had been in public jobs all his life, with the greatest possible credit.

He had shown the Society how valuable it was to have someone presiding at their meetings whose knowledge was not too strictly limited specifically to orthodontics, but who also had a very good knowledge of that subject.

In conclusion, Mr. Pringle said he would thank Mr. Taylor for all his years as the greatest money spinner for the Society, when he had acted as Librarian and had brought in handsome dividends.

The vote of thanks to the retiring President was carried by acclamation.

The President's Valedictory Address

The retiring PRESIDENT (Mr. A. G. TAYLOR) thanked Mr. Pringle for his kind words, and the Members for their applause.

In the past year there had been no crisis (except the President's absence from the February meeting owing to an upper respiratory infection) and the Society had continued to flourish. This had been due, in no small part, to the kindness, efficiency, and devotion of the Secretary and other officers.

The Council would lose the services of Mr. J. S. Beresford, who had been Treasurer from 1952 to 1961 and since then Curator: and the new President would suffer the loss of Mr. B. C. Leighton, who had been the Secretary for the past five years, and who had guided him (Mr. Taylor) without a stumble over the past year.

The Country Meeting at Norwich had been, he liked to think, a great success as a professional meeting, as a social event, and from the gastronomic viewpoint. It had broken new ground, and it was becoming evident that the Country Meeting was calling the tune to which this Society would dance.

Mr. Taylor said it now fell to him to summon Dr. Tulley to the dais and to offer him to the Society as their President for 1964.

The retiring President (Mr. A. G. Taylor) then invested Dr. W. J. Tulley with the Insignia of Office as the Society's President.

Dr. W. J. TULLEY said he was very sensible of the honour the Society had done him in electing him as its President: he just hoped he could be a good boy for a year.

It was his pleasant duty to wish all Members the compliments of the season, and announce that the date of the next meeting was Monday, 13 January, 1964, when the Presidential Address entitled '*That Unruly Member*' would be delivered.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDING SEPTEMBER 30, 1963

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22 Queen Street, London, E.C.4

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1963

1962						1962					
£	£		£	s.	d.	£	s.	d.	£	£		£	s.	d.	£	s.	d.
11		To *Museum Rent*				11	7	6			By *Members' Subscriptions:*—						
		,, *Meeting Expenses:*—								1536	Subscriptions	1524	15	7			
	47	Hire of Hall	49	3	0					2	Arrears Collected	90	14	3			
	71	Refreshments	64	17	4				1538						1615	9	10
	134	Reporting	122	14	10				183		,, *Sale of Transactions*				268	4	9
	8	Lantern and Films	6	9	6						,, *Interest Received and Accrued:*—						
	40	Country Meeting (net)	78	14	5					32	Savings Certificates	42	1	8			
	26	Northcroft Memorial Lecture (inc. expenses)	28	13	0					19	5¼% Hertfordshire C.C. Stock (net)	19	5	10			
326						350	12	1			5½% Corporation of London						
		,, *Chapman Prize* (1962)				26	5	0		16	Stock (net)	16	1	8			
		,, *Printing:*—								22	3% Funding Stock	21	13	8			
	964	Publications	774	14	5					50	5% Defence Bonds	50	0	0			
	137	General Printing and Stationery	196	13	11					16	Post Office Savings Bank		14	0			
1101						971	8	4		2	Bank Deposit Interest	8	0	11			
19		,, *Library and Journals*				15	12	6			J. & P. Coats, Patons and						
65		,, *Postage*				75	0	8		12	Baldwins Ltd.	22	17	10			
21		,, *Secretarial Assistance*				107	4	9			City of London Real Property						
53		,, *Honoraria*				22	1	0		6	Co. Ltd.	10	4	3			
26		,, *Accountancy*				36	15	0			British Insulated Callenders						
4		,, *Insurance*				4	8	6		9	Cables Ltd.	17	2	11			
4		,, *Sundry Expenses*				6	16	4		5	Royal Insurance Co. Ltd.	9	14	1			
		,, *Depreciation of Furniture and*								9	(2½% Consolidated Stock)	—	—	—			
31		*Equipment*				30	0	0	198						217	16	10
		,, *Excess of Income over Expenditure for the year*				503	15	9	36		,, *Income Tax Recoverable* (estimated)				59	16	0
£1955						£2161	7	5	£1955						£2161	7	5

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1963

1962 £	£		£ s. d.	£ s. d.
		Accumulated Fund:—		
	4960	Balance as at 1st October, 1962 ..	4757 0 10	
	294	*Add:* Excess of Income over Expenditure for the year	503 15 9	
	5254		5260 16 7	
	497	(*Less:* Loss on Sale of Investment)	— — —	
4757				5260 16 7
		Creditors and Reserves:—		
	1850	Publications printing reserves (estimated by Hon. Treasurer) ..	1810 0 0	
	52	Northcroft Memorial Lecture ..	26 5 0	
	13	Hire of Hall	13 10 0	
	10	Museum Rent	10 10 0	
	29	Subscriptions in Advance.. ..	49 1 6	
	6	Petty Cash Accounts	6 1 1	
	26	Accountancy	36 15 0	
1986				1952 2 7
£6743				£7212 19 2

J. F. PILBEAM, P. BURKE } *Hon. Auditors*
J. S. ROSE, *Hon. Treasurer*

1962 £	£		£ s. d.	£ s. d.
		Fixed Assets:—		
		Furniture and Equipment Balance at 1st October 1962	120 0 0	
		Less: Depreciation	30 0 0	
120				90 0 0
		Investments at Cost:—		
	991	1200 National Savings Certificates plus accrued interest	1033 6 8	
	1000	£1180 3% Funding Stock 1959/69	1000 5 0	
	1000	£1000 Defence Bonds	1000 0 0	
	597	£600 5½% Hertfordshire County Council 1965	597 9 6	
	509	£500 5¼% Corporation of London 1976/79	508 10 9	
	497	230 J. & P. Coats, Patons and Baldwins Ltd. £1 Ordinary Shares	502 3 6	
	479	£115 City of London Real Property Co. Ltd. Ordinary Stock ..	478 17 9	
	484	£160 British Insulated Callenders Cables Ltd. Ordinary Stock ..	455 2 5	
	479	£50 Royal Insurance Co. Ltd. Stock	478 10 0	
6036				6054 5 7
		(Approx. Market Value at 30.9.63 £6295)		
36		*Income Tax Recoverable*		95 17 10
		Cash at Bank:—		
	334	Westminster Bank Limited ..	451 14 4	
	16	Post Office Savings Bank ..	16 18 5	
	200	Deposit Account	500 0 0	
550				968 12 9
1		*Cash in Hand*		4 3 0
£6743				£7212 19 2

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

1*st November*, 1963.

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